ECHINODERMS FROM AUSTRALIA

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INTRODUCTION

Unusual opportunities for studying and collecting echinoderms on the coasts of Australia in recent years warrant the publication of this account of the material accumulated.

In 1929, a liberal grant from the Carnegie Institution of Washington, supplemented by a generous gift from the Australian National Research Council and aid from the Museum of Comparative Zoölogy, enabled me to spend nearly six months in active collecting in Australian waters. Landing at Darwin, N. T., June 13, we carried on work in that vicinity until the end of July, both by shore collecting and by dredging in shallow water. Mrs. Clark accompanied me and Mr. Arthur A. Livingstone of the Australian Museum, Sydney, joined us at Darwin, remaining with us for some four months. Mrs. Clark made water color sketches from life of many of the more interesting echinoderms and frequently aided in the shore collecting. Mr. Livingstone devoted himself to assisting me in every possible way and I cannot speak too highly of his invaluable coöperation. I do not know how to adequately express my appreciation of, and my gratitude for, the indefatigable assistance of these two fellow-workers. But work at Darwin would have been seriously handicapped without the coöperation of the hospitable residents of that community. The chairman of the Northern Territories Commission, Mr. James Horsburgh, most generously gave us the use of his residence, on the very shore of Port Darwin, for a laboratory, and a more attractive and satisfactory place for such work is not to be found on the northern coasts of Australia. In every way possible, Mr. Horsburgh helped us, and showed his unfailing interest in our work throughout our stay of more than six weeks. To Colonel Robert H. Weddell, the Resident Commissioner at Darwin, our thanks are also due, for such aid as he could give.

Shore collecting in the immediate vicinity of Darwin is very poor and it was necessary to make frequent visits to East Point, six miles out from town, in order to determine what the normal intertidal and low-tide fauna of the region really is. Mr. Jack Wetter was engaged to provide transportation for these excursions and soon became a constant and invaluable helper in many ways. Through him we were enabled to get a motor boat and thus could carry on dredging in Port Darwin. Without this we should have left Darwin with a meagre and inaccurate idea of the echinoderms which occur there. My obligations to Mr. Wetter are therefore very great and very real and I am glad to thus express my appreciation of his services. To Mr. and Mrs. F. A. K. Bleeser, our most sincere gratitude is due for much helpful advice and countless favors, evidence of a friendship which has enriched life ever since. Thanks are due, and here gladly extended to the numerous dwellers at Darwin who helped us with gifts and loans of specimens, and suggestions as to good collecting grounds. Especially we thank Mrs. Gordon, our kind hostess at the Victoria Hotel, Mr. P. W. Wilson, Mr. and Mrs. Joseph Hardy, Mrs. Jessie Littlefield, and Mr. E. J. Foster.

From Darwin, we travelled westward to Broome, by the Western Australian government's boat, the "Koolinda." During this journey, we had the opportunity of visiting two ports which appear on an ordinary map to give promise of being good collecting grounds. The first of these is Wyndham, at the head of Cambridge Gulf, where it is not even necessary to land to realize its utter unfitness as a home for echinoderms. The amount of mud in the water of Cambridge Gulf is simply amazing and the absence of suitable reefs and shores is perfectly obvious. The second port of call was Derby, at the head of King Sound. The entrance to the Sound is marked by attractive islands and gives promise of good collecting but the vicinity of Derby is as hopeless as Wyndham, barren mud flats and mangrove swamps stretching away east and west as far as eye can see. Coming out of King Sound and rounding Cape Leveque, one enters a very different area and the clear water and numerous shore reefs as Broome is approached give promise of an abundant marine fauna.

This promise is not belied! Broome is beyond doubt a paradise for a marine zoologist. The clear water, the firm bottom of Roebuck Bay, the reefs and tidepools at Entrance Point and Gantheaume Point, the very great rise and fall of the tide (exceeding thirty feet in September), combine to provide conditions extraordinarily favorable to animal life. Sponges, worms, echinoderms (especially holothurians), crustaceans (especially crabs), mollusks, and ascidians abound not only in number of individuals but in diversity of genera and species. Shore collecting anywhere, at almost any time except high water, is more or less rewarding, but at very low water surpasses description, while dredging constantly yields a wealth of forms of amazing variety. We had planned to stay a month at Broome — we stayed two — and left with the keenest regret, well conscious that we had not begun to exhaust the possibilities of the region.

We met with the same kindness and cordial hospitality at Broome to which Darwin had introduced us. Everyone was willing or eager to help and it is impossible even to mention all those to whom our thanks are due. Captain A. C. Gregory, whose extensive pearl fisheries make him a well-known figure on the northwest coast, generously provided us, without cost, a building equipped with electricity and running water, located almost at high water mark and very convenient for the nearby collecting grounds. To express here, as I gladly do, sincere thanks for this indispensable help is but a meagre return. I wish to thank particularly also, Mr. Reginald A. Bourne, master of the pearling lugger "Bonza" who became greatly interested in our work and rendered invaluable assistance in the matter of dredging and visiting more distant places. Thanks to the "Bonza" we collected at several points on both sides of La Grange Bay and even as far west as Wallal. Mr. Bourne also made it possible for us to visit pearling vessels at work and enlist the aid of their divers in bringing up specimens from the bottom where they were gathering shell. The Resident Commissioner, Colonel W. O. Mansbridge, gave me some valuable sea stars from the Lacepede Islands which were secured by pearlers while working in that vicinity, an area we could not visit. Among the many to whom thanks ought to be expressed are Captain Beresford E. Bardwell, Mr. W. F. Clarke, Mrs. W. H. Milner, Mrs. S. V. Ogilvie, and Mr. and Mrs. Stanley Pigott.

During the weeks we were at Broome, we were able to make a most interesting and profitable visit to the lighthouse at Cape Leveque where we were hospitably entertained for three days by the keepers, Mr. and Mrs. Newman and Mr. and Mrs. Robson, to whom our thanks are here cordially tendered. The success of this excursion was largely due to the hearty coöperation of Mr. Jack Tytherleigh, who took us in his car, and to Mr. and Mrs. Stanley Dewar, then living at Beagle Bay, at whose suggestion the visit to the Cape was made. Thanks are due Mrs. Dewar also for her help in the shore collecting.

We left Broome, October 1, for Perth and en route stopped at Onslow, where a few hours hunting along the shore yielded no echinoderms; at Cossack, which looked much more promising and is reported to be an excellent collecting ground; at Carnarvon, where conditions looked far from favorable; and at Geraldton, where a full day's work along the shore both north and south of the jetty yielded a number of interesting echinoderms. We reached Fremantle, October 8, and next day, at Perth, entered upon the contacts with Australian Museums and scientific men, which have proven so pleasant and so rewarding. The generosity and cheerful helpfulness of my colleagues in the Commonwealth have been so great and so delightful that any adequate expression of gratitude is out of the question, but I must bear testimony to them as enthusiastically as I can.

At Perth, where I had planned to stay but two days, Mr. L. Glauert of the Museum and Dr. E. W. Bennett of the University of Western Australia made three weeks pass all too quickly. Shore collecting at Point Peron and Rottnest Island, dredging in the area between Fremantle and Garden and Rottnest Islands, and a two days excursion to Bunbury and Koombana Bay, yielded a surprising number of echinoderms, including several new to science. To add to these treasures, Mr. Glauert permitted me to search the Museum shelves and Dr. Bennett laid before me the accumulations in the Biological Laboratory and Museum at the University, and either as gifts or loans everything of interest was unreservedly added to my store. Besides these two bountiful friends, Dr. N. T. M. Wilsmore, Professor of Chemistry at the University, and Mr. Duncan Swan and Mr. D. L. Serventy, students in the Biological Department, made me their lasting debtor. It is a pleasure to offer my very sincere thanks to the Honorable P. Collier, Premier of Western Australia, for a pass on the railroads of that state for myself and an assistant, and to Mr. F. Aldrich, Chief Inspector of Fisheries, for the use of the Department's boat for my dredging excursions. Without this generous help, so cordially given, I could not have accomplished half as much during my delightful three weeks.

Leaving Perth, by the famous transcontinental train, on October 21, we enjoyed the three days journey across Western Australia and the extraordinary Nullarbor Plain, into South Australia, to the pleasant city of Adelaide. A week's stay here was made profitable through the cordial assistance of Mr. Herbert M. Hale, who enabled me to enjoy the very unusual experience of collecting living echinoderms (at Port Willunga) in the morning and fossil echini (at Blanche Point, Maslin Bay) in the afternoon. Mr. Hale also loaned me many important specimens which were needed for further study, and enabled me to examine at the Museum much valuable material both recent and fossil.

From Adelaide we went on to Melbourne, where Mr. J. A. Kershaw of the Victorian National Museum and Dr. Frederic Chapman, the Commonwealth Palaeontologist, were most cordially helpful in enabling me to see much important material. Mr. Kershaw very kindly sent to Cambridge as a loan for critical study a number of interesting echinoderms. From Melbourne, I went to Hobart, where Mr. Clive Lord, Director of the Tasmanian Museum, whose recent death is such a loss to Australian scientific circles, did everything in his power to make my brief visit delightful and profitable. Thanks to the generous coöperation of the Chairman of the Sea Fisheries Board, Col. J. E. C. Lord, a day was spent dredging in the estuary of the Derwent and I was thus enabled to see a fauna as different as can be from that of the vicinity of Broome. Professor T. T. Flynn of the University, now at Queens University, Belfast, Ireland, was most generous in presenting me with much valuable material which he had himself collected at several points on the Tasmanian Coast. To all of these colleagues, I offer my best thanks.

Our next stop was at Sydney, where ten very profitable and delightful days were spent in collecting in Port Jackson, at Long Reef and at Gunnamatta Bay, and in studying material at the Australian Museum. Dr. C. Anderson, Director of the Museum, did everything possible to aid me and to demonstrate the hospitality, wealth and efficiency of the great institution of which he is the honored and capable head. My debt to him and to the splendid and most friendly staff of the Museum can never be adequately set forth — had I the honor to be one of their own number, I could not have been given more or better aid. My particular debt to Mr. Arthur A. Livingstone, the Curator of Echinoderms, has already been mentioned. Mr. Melbourne Ward was most generous in placing at my disposal his motorcar and motorboat during my stay in Sydney. As he also took an active part in the collecting done, my obligation to him is very great. It is a pleasure to express here my heartiest thanks to all my colleagues at Sydney.

As our return to the United States was via China and Japan, it was possible to spend a day in Brisbane, and so visit the Queensland Museum and enjoy the hospitality of Mr. Heber A. Longman, the Director. While the collection of echinoderms is not extensive, there is much noteworthy material on display, especially a series of Oreasters from the northern Queensland coast. Like his colleagues at the other Australian Museums, Mr. Longman was more than willing to loan material and assist my work in every possible way. I offer him my very sincere thanks.

After my return to Cambridge in 1930, an expedition to Australia was planned at the Museum, for the purpose of adding to our collections of the land fauna, particularly vertebrates and insects. It was not intended to include the marine fauna, but for various reasons, which need not be discussed here, it was decided that I should join the party in Sydney, in March 1932. Thanks to a generous grant made by the Milton Fund of Harvard University, it was possible for me to carry out three projects which were not possible in 1929, and which seemed quite essential to a proper rounding out of my studies on Australian echinoderms. These projects were, visits to Lord Howe Island, in the Tasman

Sea, where the southernmost coral reefs of the world occur, and to Port Essington, on the Coburg Peninsula of the Northern Territory, where the first British settlement on the northern coast of the Continent itself was attempted; and a month of dredging at Broome, to exploit the very rich echinoderm fauna found there in 1929.

At Lord Howe Island, thanks to the courtesy of the Trustees of the Australian Museum, and the characteristic coöperation of Dr. Anderson, I had the assistance once more of Mr. Arthur A. Livingstone. During the three weeks, which we spent on the island, Mrs. Clark, Mr. Livingstone and I, often aided by volunteer assistants, collected all of the 18 species of echinoderms previously known from the Lord Howe reefs and beaches, and 36 others, including several new to science. A brief discussion of the echinoderm fauna of the island will be found on pp. 559 of this report. Particular thanks are due to Mr. Robert Baxter, Mr. and Mrs. Reginald Kirby and Miss Karna Birmingham for their very kind, and often indispensable help in our work at Lord Howe.

The main purpose of the visit to Port Essington was to examine the littoral echinoderm fauna of the Coburg Peninsula and see whether it is similar to that of Darwin and equally poor, or whether the poverty of the fauna at Darwin is due to some local conditions. It was of course necessary to use Darwin as the base from which this excursion could be made, and we were extraordinarily fortunate in the combination of circumstances which gave us the required amount of time between our arrival on the monthly boat from Sydney and the departure of the bimonthly Western Australian steamer for Broome; which offered the best possible condition of the tide (for that time of year); and which enabled us to secure the services of Captain Jack Hayles of the motorship "Maroubra" whose hearty interest and coöperation in our work could be exceeded only by his knowledge of the coast and ability as a seaman. To him I am glad to offer my sincere thanks for making the excursion well worth the trouble and expense. My friend, Mr. F. A. K. Bleeser of Darwin went with me and proved an invaluable assistant in the collecting as well as a most congenial companion. We made three landings on the peninsula during favorable conditions of the tide — one near the lighthouse at Cape Don, one at Smiths Point, at the entrance and on the eastern side of Port Essington, and one at Coral Bay on the western side. Best of all we had several hours at Allaru Island, a small islet lying well off shore to the west of Port Essington. At none of these points was the collecting notable in itself, but the similarity to that in the vicinity of Darwin was so obvious, there was no doubt left in my mind that the comparative poverty of the fauna at Darwin is not due to local conditions but is characteristic of the whole coast of the northern territory.

The month of dredging at Broome was all that had been expected and more, the chief drawback being the weather which was very different from that we had so thoroughly enjoyed in August and September, 1929. The winter days of June were regrettably short, allowing only about eleven hours of daylight in which we could work. There was much overcast sky and some rain, and on many days there was too much wind to permit dredging very far off shore. This prevented a greatly desired visit to the Lacepede Islands, northeast of Broome, but Mr. Bourne and other local authorities do not think that conditions at those islands differ in any essential way from those along the coast, or that there is any reason to expect any differences in the fauna. The pleasure and success of the month's work were very largely due to the hearty coöperation of Mr. R. A. Bourne, master of the "Bonza," who had done so much to help me in 1929. In addition to fulfilling his contract with me satisfactorily in every detail so far as weather permitted, Mr. Bourne provided at his own expense, a diver and the necessary pump and accoutrements to assist us. While this was an advantage in some ways, and the diver brought up many desirable specimens including species we did not and probably could not hope to get with a dredge, it involved a very great waste of time, for a diver necessarily works very slowly, covers a small area and sees only relatively large and noticeable forms. Mr. Bourne and his admirable crew of three aboriginals ("abos," for short) Paddy, Ramy and McKinna, were so assiduous in dredging that we covered a great deal of ground when not delayed by the diver. We left Broome each Monday, as early as wind and weather permitted and returned with our spoil late Saturday evening. If there is a more fascinating sport than dredging under pleasant conditions on good bottom, I do not know what it is, and those weeks working up and down nearly three hundred miles of coast, east and west of Broome, will always be looked back upon as among the most thrilling of my life. My thanks to Mr. Bourne are most deep and sincere. The friends we had made in 1929 were most cordial in helping us in every way, and it is a pleasure to thank them again.

It may appropriately be mentioned here that Captain Beresford E. Bardwell in 1933 made a trip to the northeast of Broome, going as far as Augustus Island and the Port George Mission. In return for a little financial help from the M.C.Z., Captain Bardwell sent us a notable collection of echinoderms, including a number of species which I did not secure, and throwing much light on the fauna east of King Sound. This collection is included in the present report and is particularly discussed on pp. 566. My heartiest thanks are here tendered Captain Bardwell for this timely and important assistance.

After leaving Broome early in July, there was little opportunity for further collecting. Our first stop on the southward journey, that at Port Hedland, permitted several hours ashore and as the tide was favorable, it was possible to gather a few interesting echinoderms. But our other ports were made late in the day and no further chance for shore work occurred before reaching Perth. There I was again the recipient of courtesies, loans and gifts from Messrs. Glauert, Bennett and Wilsmore, and also from Professor G. E. Nichols of the Zoological Department of the University, who was indefatigable in his service and unceasing in his kindness. The winter weather was not propitious for collecting and our single dredging trip was badly handicapped by wind and rain.

The hospitality of Mr. and Mrs. Joseph Hardy, whose friendship we had made at Darwin in 1929, was so generous and delightful during our two weeks stay in Perth, it cannot be passed over in silence, but words of thanks are quite inadequate, especially since the memory of it is so unspeakably saddened by the lamentable death of our young hostess only a year later.

From Perth, all the collections made at Darwin and on the Coburg Peninsula, as well as the large amount of material gathered at Broome, were sent to Sydney, and there, by the courtesy of the Australian Museum, they were repacked with the Lord Howe Island collections and with loans from the Museum, and all were sent in one shipment to Cambridge. For this great assistance, I take pleasure in thanking the Trustees of the Australian Museum, Dr. Anderson and the very efficient and kind packer, Mr. Henry S. Grant.

The entire amount of material thus accumulated from my two visits to Australia consists of 11,484 specimens, representing 422 species of 184 genera. Of this, 9,647 specimens were collected by Mrs. Clark, Mr. Livingstone and myself, aided of course by many others, particularly by Mr. Bourne at Broome. The balance is made up of 955 gifts and 700 loans from our bountiful Australian colleagues and friends and the 182 sent by Captain Beresford E. Bardwell of Broome, as already mentioned. In the following pages this notable mass of material is treated first systematically by classes, and then geographically by areas visited. In genera containing representatives of more than one species, previously known forms are treated first, then the new species; in each group the species are arranged alphabetically. The source of the material is mentioned under each species. When no other source or collector is mentioned, it is to be understood that we were the collectors. It is hoped that a subsequent report may give a full account of the echinoderm fauna of Australia as at present known, with a discussion of its apparent history and relationships.

I wish to express here my deep sense of obligation, and my sincerest thanks, to the Carnegie Institution of Washington, the National Research Council of Australia, and the Committee in charge of the Milton Fund of Harvard University for the financial help which made the collecting of the material and the preparation of colored plates possible; to Mr. George R. Agassiz for the financial help, which made possible the colored plates and prompt publication; to my wife, Frances L. S. Clark, and to Eugene N. Fischer, for their patience and skill in making the colored illustrations for this report so satisfactory; to Mrs. Clark further for much help in the preparation of the manuscript, particularly the index, bibliography and faunal lists; to Mr. F. P. Orchard for his admirable efficiency in making the necessary photographs; to Mrs. Elizabeth Grundy, Mrs. Carmen Witter and Mrs. Anna O'Connor for their skill and care in typing the manuscript; to Mrs. Marjorie H. Pattee for invaluable help in connection with checking references and catalog numbers, and tabulating statistics; and particularly to Dr. Thomas Barbour, Director of the Museum of Comparative Zoölogy, whose generous interest and unfailing sympathy have made it possible for me to enjoy the extraordinary opportunities I have been given, and to prepare unhindered by routine duties, this voluminous report.

CRINOIDEA

The collection of crinoids contains 910 specimens representing 20 genera and 32 species. Of the genera, two are new so far as the name is concerned, but one is proposed for a species described many years ago whose generic position has hitherto been a puzzle. Of the 32 species only 7 are new and of these 4 make up the new genus of Antedonidae discovered at Broome. It is not strange that the number of new species is small, for much attention has been given to Australian and East Indian crinoids during the past thirty years.

The new genera are:

Aporometra, type *Himerometra paedophora* H. L. Clark. There are two other species in the genus, one of which is described beyond.

Monilimetra, type *M. nomima* sp. nov. There are three other species in the genus, all found at Broome and hitherto undescribed.

The 7 new species fall into three genera as follows:

Petasometra brevicirra	W. A., False Cape Bossut.
variegata	N. T., Darwin.
Aporometra occidentalis	W. A., Bunbury
Monilimetra bicolor	W. A., Broome.
lepta	W. A., Broome.
nomima	W. A., Broome.
poecila	W. A., Broome.

Crinoids are common, even abundant, in many places on the tropical coasts of Australia but below latitude 27° few species occur on either the eastern or western sides of the continent, or on the southern coast. Nor are these few species of the temperate coasts notable for either size or color, for they are small and only one is at all showy. Hence they make up an inconspicuous part of the marine fauna. On some parts of the northern coast, however, and on the northern part of the Great Barrier Reef, comatulids are abundant and conspicuous, even in shallow water and along shore near low water mark. But they are seldom found where the water contains any silt or there is any deficiency in either salinity or oxygen. Consequently they occur in abundance and in all their full beauty only where the water is kept in the best possible condition by strong tidal or other currents. They are therefore apt to be more or less local in their distribution. Most comatulids live a sessile life, moving about little or not at all, but a few of the smaller species (especially in the Antedonidae) are good swimmers if sufficiently stimulated. While some species occur, often in abundance, on open, hard, sandy bottoms, where they attach themselves to any object, rock, shell or alga, fixed to the bottom, most of the larger forms occur in sheltered recesses under or among rocks near and below low water mark, or among sponges, gorgonians and stony corals.

Of the 32 species in the present list, 21 occur in the Broome region, and 14 were found only there. At Darwin, we found 8 species but 6 of these occur also at Broome and at least 5 occur on the Barrier Reef. Only 5 species are at hand from the western Australian coast. Obviously Broome is a particularly favored spot but this is quite to be expected in view of the purity of the sea-water and the great rise and fall of the tides.

The literature dealing with Australian crinoids is almost wholly the work of Austin Hobart Clark, with minor contributions by Gislen (1919) and the present writer (1909, 1914, 1915, 1916, 1921, 1928, 1932). Mr. Clark's contributions to our knowledge of the East Indian fauna is equally valuable and his monograph on the "Siboga" comatulids is a ''sine qua non'' for any worker on the crinoids of the Indo-Pacific region. His recent magnificent monograph on the Comasteridae (1931) brings order out of chaos in a masterly way and lays a foundation for all future work with that perplexing family, which is not likely to be essentially altered in years to come.

In the study of the present collection I have enjoyed the inestimable advantage of frequent consultation with Mr. Clark either by personal conference in Cambridge and Washington or by correspondence. His open-minded readiness to see my side whenever we disagreed has made it possible for us to discuss debatable points in a very satisfactory manner, and his extraordinary knowledge not only of the animals themselves but of the literature dealing with them, has enabled him to save me from oversights and blunders. Of course, Mr. Clark cannot fairly be held responsible for any errors that may be found in the present report but for whatever merit it may possess much of the credit should be given to him. It is a pleasure to offer here my sincerest thanks to my friend of more than twenty-five years, for his ready and generous assistance.

In collecting crinoids at the Murray Islands in 1913, I soon learned that their reactions to chemicals were very different from those of other echinoderms, and the experiences of 1929 and 1932 have confirmed the impressions formed at that time. No narcotic has been found which will cause them to relax, as Epsom salts do for other echinoderms, but no real effort has been made to find such a substance as it is quite unnecessary. All of the comatulids which I have taken alive kill quickly and satisfactorily, without autotomy or distortion, in strong alcohol. If it is desired to have them die with the disk exposed, they should be lifted carefully from the sea water and plunged into alcohol deep enough to cover them, in a pan or flat dish large enough to permit the full expansion of the arms. It does not much matter whether they be plunged with oral side down or up, but it is more convenient to seize the centrodorsal with thumb and finger (or forceps) and put them in the dish of alcohol, mouth down. They should be held down for a few moments till all movement has ceased, after which the arms can be arranged as desired. If the specimens are to be dried, as is often desirable for convenience in packing and in subsequent storage and study, a little corrosive sublimate should be put in the alcohol. After thorough saturation with such poisoned alcohol the specimen may be dried as convenient by placing, mouth down, on a sloping board. For the best results, the killing should be done very soon after capture. Comatulids are surprisingly sensitive to stale sea-water and specimens left in a bucket for even an hour or two may begin to go to pieces, shedding first the distal pinnules and then the tips of the arms; finally the middle and basal parts of the arms break up. Once this process begins it is difficult to stop it, and such individuals will often go to pieces when placed in alcohol.

COMASTERIDAE

Comatella maculata

Actinometra maculata P. H. Carpenter, 1888. "Challenger" Comat., p. 307.
Comatella maculata A. H. Clark, 1908a. Smithson. Misc. Coll., **52**, p. 207.

This widespread species occurs at Broome but is not very common. We also found it at Cape Leveque but only secured two small specimens. Some of the specimens taken at Broome are of very large size, the arms being 100 mm. or more in length; in the largest specimen, which has 20 arms and in the dry condition is nearly or quite black, the longest arms are 150 mm. long. The cirri are XXIII, 18–22. The smallest specimen has 17 arms, 50–60 mm. long, while one a trifle larger has only 13 arms; in this latter specimen the cirri are XX, 16–17. Most of the specimens have more than 23 cirri, but the number of segments is only 16–20. The smaller specimens give evidence of a dark green tint which becomes yellowish distally on the arms. The cirri are, in all cases, more or less purple at least distally.

The material at hand consists of the following 10 specimens.

Western Australia: Broome, under rocks near low water mark, Entrance and Gantheaume Points, August and September, 1929. 1 specimen.
Broome, dredged, June, 1932. 2 small specimens.
Cape Leveque, under rocks, August 1929. 2 specimens.

CAPILLASTER MULTIRADIATA

Asterias multiradiata LINNÉ, 1758. Sys. Nat., ed. X, p. 663.
Capillaster multiradiata A. H. CLARK, 1909. Vid. Med., p. 134.

This crinoid is characteristic of the East Indian region, ranging only (so far as we yet know) to the Maldive Islands on the west and the Carolines on the east, to Formosa on the north and tropical Australia on the south. There are numerous Australian records but the immediate vicinity of Broome furnished all of the ten specimens at hand. There *multiradiata* occurs under or among rocks near low water mark and is also occasionally dredged on the shoals, but it is a relatively uncommon and inconspicuous form. The most noticeable of the present series is one with 16 arms, most of which are about 75 mm. long; there are four II Br series and two III Br. A smaller individual, with most of the arms broken, has only 13, and there are but two II Br and one III Br series. The largest specimen has 42 arms about 100 mm. long; the cirri are XXIV, 24–26. In other specimens the cirri range from IX to XXIII and the number of segments from 15 to 26. Most of these specimens of *multiradiata* appear gray, fawn-color or light brown dorsally, much darker orally; the pinnules are sometimes finely spotted with silvery white. One specimen is a dull, dark purple, and the cirri in most specimens are more or less purplish near the tip; in other cases they are olive-green.

COMATULELLA BRACHIOLATA

Comatula brachiolata LAMARCK, 1816. Anim. s. Vert., 2, p. 535.
Comatulella brachiolata A. H. CLARK, 1911. Amer. Jour. Sci. (4) 32, p. 130.

This little comatulid is one of the characteristic marine animals of southwestern Australia. We met with it only at Bunbury but there is a specimen at hand from Cottesloe Beach. Dredging in Koombana Bay, one or two miles west of the breakwater in 5–8 fms., Oct. 26, 1929, yielded a number of specimens and my field notes say: This "Comatula was largely a rosy-red in life, dorsally more or less variegated — the cirri a very bright red, more scarlet, but there is not a sharp contrast between cirri and the calyx." "Rather a rigid thing, came up in dredge, opened out flat, attached by cirri and even pinnules also, to seaweeds. Killed usually without a tremor!" (The killing was done by plunging at once into strong alcohol).

The 11 specimens at hand were taken as follows:

Western Australia: Cottesloe Beach. Property of Perth Museum. 1 fine specimen.

Bunbury. Collected and presented by Naturalists Club, Bunbury; drift on Back Beach, January, 1930, 1 badly damaged specimen.

Bunbury, Koombana Bay, 5–8 fms., October 26, 1929, E. W. Bennett and H. L. Clark leg. 9 fine specimens.

VALIDIA ROTALARIA

Comatula rotalaria LAMARCK, 1816. Anim. s. Vert., **2**, p. 534.
Comatula (*Validia*) *rotalaria* A. H. CLARK, 1918. "Siboga" Unst. Crin., p. 6.

This strikingly handsome crinoid is one of the characteristic species of tropical Australia. We met with it while dredging near Broome in 1929 and again in the same region in 1932 but did not take it elsewhere. It has been reported from as far south as Port Molle, Queensland (20° 30′ S.) and Baudin Island, Western Australia (14° 08′ S.). The specimens taken at Broome therefore extend the known distribution considerably to the southwest. They range from an immature individual with 22 arms, of which 13 are (or were) 30–50 mm. long and 9 are 5–16 mm., to a fine adult also with 22 arms, but having them 75–125 mm. long, nearly all over 100. The smaller specimen has 2 cirri with about 15 segments, but the larger has no trace of cirri or of cirrus sockets. Another small specimen has 20 arms, 40–70 mm. long (mostly about 60) but has the cirri VIII, 14–18, interradial in position as in *Comatula pectinata* var. *purpurea*. Both the small specimens of *rotalaria* show the fleshy knobs on the disk so often conspicuous in larger specimens, but curiously enough neither shows the least similarity in arm arrangement to *Comatula etheridgei* A. H. Clark, which is now believed by Mr. Clark to be the young of *rotalaria* and the types of which had the longer arms about 70 mm. Apparently not all *rotalarias* pass through an *etheridgei* stage or else they pass through it while still very small. Some of the specimens dredged at Lagrange Bay in 1932 are superb individuals with 30 or 31 arms, 140 mm. long. In specimens with 29 arms or more, there are 6 arms on each ray (or on all but one) with the III Br series always on the inner side of the II Br axillary.

The color of the alcoholic specimens is a grayish brown lightest on the centrodorsal and on the backs of the arms, darkest orally. The dry specimens are very different: the calyx and basal part of arms is yellow-brown with a distinctly greenish cast, passing more or less gradually into a dull rose red or deep pink; in one specimen only the distal part of the arms is distinctly pink but in all of the others, the general appearance of the whole specimen, excepting only the calyx and oral face of disk, is strikingly deep pink. In the young specimens, the cirri are a very light brown or fawn color.

In life, the colors are very different and the following extracts from my field notes may be quoted as showing the impression made on the collector when he first meets with this splendid comatulid.

In 1929, I wrote: "No cirri. 20 arms; yellow or greenish on centrodorsal and out on base of arms dorsally, but pinnules silvery dorsally, more or less yellow-tipped; sutures dark, more or less purplish; oral surface very dark. Exquisite." On June 7, 1932, we were dredging in 4–5 fms. at the entrance to Lagrange Bay and took several specimens of *rotalaria*. My field notes say: "A superb creature marvellously variegated with black and white orally, greenish-yellow aborally. No cirri. 20 or more arms. . . . Dry specimens show complete change of color."

It seems to me that the differences between *rotalaria* and the ten-armed species of Comatula are sufficiently important to warrant treating the subgenus proposed by A. H. Clark as a genus. Nothing is gained by using a subgeneric group for this very distinct species, and I have therefore called it *Validia rotalaria*. The 14 specimens at hand were taken as follows:

Western Australia: Broome, on Pearl Shoal, 5–7 fms., September 12, 1929. 1 fine adult.
Broome, east of Pearl Shoal, 7–8 fms., September 14, 1929. 3 fine adults.
Off entrance to Lagrange Bay, 4–5 fms., June 7, 1932. 7 very fine adults.
Broome, June, 1932. 1 adult and 2 small specimens.

COMATULA PECTINATA

Asterias pectinata LINNÉ, 1758. Sys. Nat., ed. X, p. 663.
Comatula pectinata DUJARDIN and HUPÉ, 1862. Nat. Hist. Zooph., p. 203.

This is undoubtedly the most abundant crinoid on the coasts of northern Australia. Under suitable conditions it swarms over large sponges and rock fragments; on one sponge brought up in our small dredge, we counted over two hundred individuals of all sizes and colors. The largest specimens have the arms opposite the mouth over 125 mm. long, with those adjoining the mouth about 75–80 mm. In small individuals this inequality of the arms is not nearly so marked and is often hardly evident. The diversity of color is very great at Broome; the most common color is red or purplish of some shade. My field notes say: "Almost black to almost white; deep purplish common; also common is whitish or pinkish with red lines on calyx and arms, and cirri red, at least at tip. Dry specimens brick red or darker." On another occasion, I wrote: "One bright crimson; one deep purple with dorsal side of arms, bright yellow. A juvenile specimen was bright scarlet, each pinnule just tipped with white; and it became bright yellow in alcohol. Several were light grayish with two dark lines on back of each arm; cirri yellowish; dried, light red brown. Some specimens dull orange or orange-brown."

The individuals of this species which have the cirri confined (usually in pairs but not rarely singly) to the interradial angles of the centrodorsal were called *Alecto purpurea* by J. Müller nearly one hundred years ago (1843) and the name has persisted ever since. Even as late as 1931, the species *Comatula purpurea* (J. Müller) is recognized by the very best authority on crinoids, Mr. A. H. Clark. In 1919, Gislen, studying material from northwestern Australia, decided that *purpurea* was no more than a variety of *pectinata* and a few years later (1923) I expressed my sympathy with this view but considered more data necessary before we could be sure what the relation between the two forms really is. The abundance of these comatulids at Broome has enabled me to secure such data, and I am satisfied that *purpurea* is not properly even a variety. That is, I do not find any reason to believe it breeds true or is confined to any locality or habitat where *pectinata* does not occur. Where living conditions are "hard" (judged, of course, by human standards) all of the *pectinatas* may be small and have the cirri characteristic of *purpurea* but where conditions are favorable, as at Broome, the two forms occur together and in about equal numbers and connecting links are not rare; these usually take one of two forms — they may be typical *purpurea* except for having three cirri at one or more interradial angles of the centrodorsal or they may be *pectinata* with the cirri lacking from 3 or 4 of the radial sides of the centrodorsal. Of course, such specimens may be arbitrarily assigned to one form or the other, but it seems to me clear that the difference is not morphological. For convenience in referring to the form with only 10 (or fewer) interradially placed cirri, we may use the phrase "forma *purpurea*." It should be noted, however, that this is not a depauperate form or peculiar in any other particular. It occurs commonly with typical *pectinata* and shows the same diversity in size, form, and color.

The failure to find *pectinata* in any form at our collecting grounds on the Coburg Peninsula or at Darwin is puzzling though I have no doubt it is due to the large amount of silt in the water. It is not impossible that in September and October, before the rains begin, the water may be clearer and this common comatulid might be found in certain favored localities. In support of this theory are three very small specimens with arms about 15 mm. long or less, which we dredged in 3–6 fms., on a bottom of sponges, gorgonians, etc., near the Shell Islands and near Channel Island, at Darwin. In life they were bright colored (variegated, red, yellow and white) but they are now pale brown or dingy white. One of these has been identified by Mr. A. H. Clark as a young *pectinata* and I see no reason to hesitate in calling the others the same. The only possible reason for doubting the identification is that we failed to find any specimens large enough to make it certain, and we did secure the adults of three other comasterids near the Shell Islands, all of which undoubtedly pass through a 10-armed Comatula stage. For the present, therefore, I list *pectinata* from Darwin only with question.

The material at hand consists of 78 specimens, of which 47 are referred to *pectinata* and 31 to "forma *purpurea*." The localities follow:

C. pectinata forma *typica.*

?Northern Territory: Darwin, near Shell and Channel Islands, July, 1929. 3 very young specimens, too immature to permit certain identification.

Western Australia: Broome, various localities, low tide mark to 8 fms., June, 1932. 36 specimens.

Broome, Pearl Shoal, 5–8 fms., August, 1929. 5 specimens.

Near False Cape Bossut, September, 1929. 2 specimens.

"Northwestern Australia, April, 1915. Capt. Due leg." Gift of E. W. Bennett. 1 specimen.

C. pectinata forma *purpurea*.

Queensland: Great Barrier Reef, Eagle Island (north of Cooktown). T. T. Flynn leg. 2 young specimens.

Western Australia: Broome, various localities, August and September, 1929. 17 specimens.

Broome, Cable Beach, September, 1929. Frances L. S. Clark leg. 3 specimens.

Broome, dredged at various localities, 4–8 fms. 8 specimens.

Near False Cape Bossut, September, 1929. 1 specimen.

COMATULA SOLARIS

LAMARCK, 1816. Anim. s. Vert., **2**, p. 533.

This large ten-armed comatulid is one of the most striking of the crinoids found on the coast of Northern Australia. Its great size, robust structure, and diversity of coloring combine to attract unusual attention. The first one seen by us was creeping along the hard, sandy bottom of Roebuck Bay in an effort to overtake the rapidly outgoing spring tide, September 21, 1929. The body, with oral side up, was raised some three inches above the sand, the weight being sustained on the tips of the ten arms. Progress was by no means slow but not rapid enough to keep up with the ebbing sea. When picked up and placed in a bucket, taken to the laboratory and killed in alcohol, this individual showed no fragility or tendency to break off its arms, which at that time were about 200 mm. long; in its present dry condition the body is 25 mm. across and the arms only 175 mm. long; there are about 20 cirrus sockets with but 6 cirri, of some 18 segments. The color of this specimen when living was as follows: centrodorsal and cirri, yellow; arms basally (on the dorsal side) of the same color but this becomes increasingly lighter distally passing through cream-color to almost white at the arm-tips; pinnules yellowish or cream-color with few or many brown bands; oral surface of pinnules and arms, brown; disk and oral pinnules a bright brown in decided contrast. A smaller specimen taken a few days later was very different in color and in its present dry state is nearly uniform light brown. A very handsome specimen with arms about 130 mm. long was dredged in 4 fms. off Cape Villaret, southwest of Broome. There are 16 cirri and these, with the centrodorsal and adjoining arm bases are dull purple; the rest of the dorsal surface is almost white while the pinnules and the oral surface are deep blackish brown in striking contrast.

These three were the only examples of *solaris* met with in 1929 but in June, 1932, we found it not rarely in our dredging, and there are 10 of these specimens at hand. The largest are superb creatures with the arms 210–230 mm. long and 6 mm. or more wide, without the pinnules. They reveal great diversity in coloring, though now chiefly brown of some shade, or deep purple. My field notes say that one specimen was notable for having "the pinnules on basal part of arm orally light blue." In another the distal pinnules terminated in yellow. Such bright colors are not indicated in the preserved specimens. One individual is so much smaller than the others, it deserves a word of comment. The arms are only 50–70 mm. long and the cirri are XXII, 15–17; the color is light brown more or less variegated with a darker shade.

COMANTHINA BELLI

Actinometra belli P. H. CARPENTER, 1888. "Challenger" Comat., p. 334.
Comanthina belli A. H. CLARK, 1911. Amer. Jour. Sci. (4) **32**, p. 130.

This notable comatulid is characteristic of the northern and northwestern coasts of Australia from the northern end of the Barrier Reef (the Murray Islands) to Shark Bay and the Abrolhos Islands in the west. It is beyond question the most beautiful marine animal found in those waters, its large size, great number of arms and extraordinary diversity of color making it very conspicuous. We took but a single specimen at Darwin but it is very common at Broome, where it often occurs near low water mark or even in pools left by the ebbing spring tides. To give any adequate account of its beautiful appearance would involve a description of nearly every specimen, which is, of course, out of the question. Suffice it to say that large individuals have more than 100 arms and up to at least 150; one specimen has apparently more than this, possibly nearly 200 but anything like an accurate count is impossible without wrecking the specimen. In life the big individuals are fully 300 mm. across, with the disk exceeding 40 (the calyx, of course, much less) and the arms 125–140 mm. long. In the largest specimen there is a VII Br 2 series on one ray; if every ray divided six times, there would, of course, be 320 arms, but it is a familiar fact that in all multibrachiate crinoids, after the first two or three forkings, the division series become very irregular. Several young individuals were taken with 30–55 arms which are 50 to 100 mm. long; the most remarkable of these is a specimen with 33 arms, 60–75 mm. long (in life), which when living had the calyx, disk, and base of arms bright lemon yellow but distally the pinnules became, gradually not abruptly, a bright turquoise blue — a most exquisite and, so far as our collecting shows, a unique color form.

The diversity of coloration shown by *belli* surpasses that of any other echinoderm with which I am acquainted. Shades of red are the least common and the most fugacious. One notable specimen is almost uniformly black, while in striking contrast is an individual with the arm bases pale olive variegated with cream-white, the centrodorsal, the interradial areas of the calyx and the distal half of the arms cream-white; many arms have broad but rather indefinite bands of dusky near the tips. Bright lemon yellow, orange-brown, deep brown, and green individuals are frequently seen and one beautiful specimen was (and to some extent still is) a fine light blue; a broad whitish band on the middle part of each arm forms a wide white circle separating the markedly blue arm bases from the lighter blue tips. Green individuals are seldom unicolor but show several shades variously intermingled. One feature of the coloration is remarkably constant—the cirri are pure white in life. Even the darkest colored specimens show this character, making it a convenient "recognition mark" — for the collector! Unfortunately in preserved specimens, the cirri generally get more or less stained and are likely to take on the color of the adjoining arm-bases. But in most of the dry specimens, they show a very considerable contrast to the rest of the animal.

A very small dry crinoid from Cable Beach, Broome, with 15 arms, 7 of which are about 45 mm. long, is referred with some doubt to this species. The cirri are XIV, 10–12 and are pure white, in contrast to the very pale brown of the arms. There are three II Br 4 and one III Br 2 and the basal segments of the lower pinnules show indications of the projecting ridges which are such a striking feature of adult *belli*. But similar projections are to be found in young *Comantheria briareus* and it is by no means easy to see any marked or constant difference between young individuals of the two species. Besides this 15-armed specimen from Cable Beach, there are three young comatulids which have given me a great deal of trouble. Mr. A. H. Clark has been so good as to critically examine the largest of these (100–125 mm. across) and thinks it is undoubtedly a "young specimen of *Comanthina belli* undergoing adolescent autotomy." The other two are smaller and differ to some extent in general appearance, but after prolonged comparison with young *belli* and young *briareus*, it seems best to consider the three identical and include them all under the present species.

The 29 specimens at hand were taken as follows:

Northern Territory: Darwin, near Shell Islands, 5–8 fms., July 25, 1929. One adult specimen.
Western Australia: Broome, August and September, 1929. 15 specimens; 1 young one of doubtful identity.
Broome, Cable Beach, September 2, 1929. Frances L. S. Clark leg. 2 specimens.
Broome, Cable Beach, September 2, 1929. Frances L. S. Clark leg. 1 very young specimen; identity not certain.
Broome. From Perth Museum. 1 specimen.
Broome, June, 1932. 7 specimens; 1 young one of doubtful identity.
Broome, Entrance Point, July 4, 1932. 1 young specimen.
False Cape Bossut, September, 1929. 1 young specimen; identity dubious.

Comantheria briareus

Antedon briareus Bell, 1882. Proc. Zool. Soc. London, p. 534.
Comantheria briareus A. H. Clark, 1911. Fauna Südwest-Austral., **3**, p. 437.

This crinoid is very common in the Broome region; we found it at Cape Leveque, and along the coast from there to Cape Bossut at least, it occurs wherever conditions are suitable. How far west and south it ranges is still open to question. It is recorded from "?Vicinity of Perth (2 specimens)" (A. H. Clark, 1911, p. 454) and a specimen in the Perth Museum (No. 9681) is said to be from "Bald Island, 28–32 fms." I am more than skeptical as to these labels. Bald Island is east of Albany on the southern coast of Australia and I do not believe that any Comantherias occur there. Moreover, the specimen is an old one, dry and in poor condition, and no number or label is attached to it. The two specimens listed by Mr. Clark from the "vicinity of Perth" were in the Michaelsen and Hartmeyer collection and it is very probable that they too suffer from a misplaced label. If actually collected by the German zoologists, I think they were taken in Shark Bay, which would then be the southern limit for this species on the Western Australian coast. That *briareus* occurs in Shark Bay is not wholly improbable but until there is further evidence than is as yet available, I think we may consider the vicinity of Cossack (Port Walcott) as about the southwestern limit of its range. East of Cape Leveque there are records from the region of the Holothuria Banks, and there is one small specimen in the present collection from Darwin.

As found at Broome, *briareus* is a very perplexing comatulid. The diversity in size, number of arms and color is very great, and there is no apparent correlation with differences in habitat. Most of the specimens were dredged and not rarely a number of specimens of diverse size and appearance came up in a single haul. But both large and small specimens of dull and of brightly colored forms were found along shore just below low water mark. The smallest specimens at hand are 50–60 mm. across while the largest has an expanse of 225; in this big individual the anterior arms measure about 130 mm. but the posterior are scarcely 80. The number of arms ranges from 21 to 65; there are a number of specimens with 40–57 arms but fully three-fourths have fewer than 40 (21–38). At first, it seemed to me probable that these individuals with fewer than forty arms represented a second species, *rotula* A. H. Clark, but the more I have studied my material the more the conviction has grown that it is impossible to recognize a second species on that basis. The diversity in color suggested that there might be a useful distinction possible along that line but this proves out of the question. The largest and finest specimens from Broome are dry and are a more or less uniform greenish-yellow dorsally; in life, these were yellow or green of some shade dorsally, with black and white pinnules in handsome contrast; in some specimens (notably the largest), the yellow does not cover the whole dorsal surface but occupies a very broad longitudinal band on the radials and all the brachials. Many of the small specimens are essentially like this and there is no question in my mind that these greenish and yellowish individuals must all be referred to a single species regardless of size and number of arms. On the other hand, many small specimens are now (and were in life) uniformly brown of some shade; the brown may be reddish, purplish, or grayish, and light or very dark; one small specimen is very light almost fawn-color but in life was "clear yellow brown" — not however with any trace of green. A few specimens are clearly intermediate between the brown and the greenish groups having the dorsal side brown, more or less spotted or marked with yellowish-green. I am, therefore, convinced that all my material must be referred to *briareus* with the comment that the tendency at Broome is toward the handsome yellow and green shades. If *rotula* is a valid species, it is not represented in my material.

Two specimens taken at Broome in 1929 are of a uniformly light gray color. One has 28 arms, 50–80 mm. long, with only 3 III Br 2 and 5 III Br 4 (no further divisions); the other has 33 arms, 60–90 mm. long, with only 5 III Br 2 and 8 III Br 4. These were at first referred to *Comanthus timorensis*, but the character of the arms and cirri has led me, after discussing them with Mr. A. H. Clark, to refer them to *briareus*. They are, of course, young and the species characters (one might even say the generic characters) are not yet fixed.

The 47 specimens which I am referring to *briareus* were collected at the following points:

Northern Territory: Darwin, near Shell Islands, about 5 fms., July 24, 1929. 1 young specimen with only 18 arms; having 4 II Br 4 and 4 III Br 2.
Western Australia: Cape Leveque, August, 1929. 1 small brown specimen with 43 arms.
Broome, Cable Beach, September 2, 1929. Frances L. S. Clark leg. 3 small specimens.
Broome, August and September, 1929. 10 adults and young.
Broome, June, 1932. 31 adults and young.
Loc. ? Labelled "Bald Island. 28–32 fms." 1 small adult with 35 arms. Loaned by the Perth Museum.

Comantheria perplexum

Comanthus perplexum H. L. Clark, 1916. "Endeavour" Ech., p. 14.
Comantheria perplexum A. H. Clark, 1931. Crinoid Monog., **1**, pt. 3, p. 506.

There is a very fine specimen, from the Australian Museum, of this species, hitherto known only from the holotype, taken in 15 fms. off Norwest Islet, Capricorn group, Queensland, in December 1930, by Livingstone and Boardman. The holotype was from off Ballina, N. S. W., 49–51 fms. The present specimen is a very fine one with 38 arms, 100 mm. long; there are only a few cirri, VI, 18. The disk was lacking in the holotype but is present in this individual. It is 17 mm. across, yellowish-gray in color, plump, with a large anal tube and covered irregularly and not closely with whitish papillae about .30 mm. in diameter. As in the holotype, the dorsal surface of this specimen is light fawn color, the oral surface somewhat darker.

Comanthus parvicirra

Alecto parvicirra J. Müller, 1841. Monatsb. Preuss. Akad. Wiss., p. 185.
Comanthus parvicirra A. H. Clark, 1908. Smithson. Misc. Coll., **52**, p. 203.

It is a puzzling fact that no comatulids which may be referred to this species were taken by us on the northern or western coasts of Australia. It is a widespread species in the Indo-Pacific region and has been recorded several times from Western Australia. There are several specimens in Mjöberg's collection from Broome and southwestward which Mr. A. H. Clark assigns to *parvicirra* (see Clark, 1931, pp. 636 and 664–666) although Gislen identified them as Comasters. But all the Comanthus which we found at Broome seem best referred to *samoana* and *timorensis*.

The only comatulids in the collection at hand which may well be assigned to *parvicirra* are 7 very small individuals from Port Curtis, Queensland, and these are much too young for certain identification. The largest is about 40 mm. across and has 17 arms; the cirri, X, 12–13, are as distinctive as any feature, and I have little doubt that this is a young *parvicirra*. The other 6 specimens are very small, 15–20 mm. across and have but 10 arms each. The only reason for calling them *parvicirra* is their association with the larger individual.

Comanthus samoana

A. H. Clark, 1909. Proc. U. S. Nat. Mus., **37**, p. 30.

This comatulid is now known from a considerable number of localities on the tropical coast of Australia and among the western Pacific islands. Its occurrence, therefore, at Broome is not surprising but is none the less interesting. It is not, however, common there for in 1929 we took it only at or near False Cape Bossut and in 1932 only one adult specimen was taken. The specimens at hand are typical and call for little comment. The smallest is about 40 mm. across, has 18 arms and the cirri are XVII, 11. There are 3 specimens with 20 arms each, the smallest about 50 mm. across. The larger specimens have 22, 23, 27, and 32 arms respectively; the largest is about 150 mm. across. The cirri range from XIX, 11–12 to XXVI, 15–16. The color is pale brown in the smallest specimen and purplish-brown or yellow brown in the other young ones. The larger specimens are more or less uniformly dull, dark brown, with a purplish or grayish cast.

The 8 specimens at hand were taken as follows:

Western Australia: False Cape Bossut, September 8, 1929. 3 adults and 2 young.
Broome, June, 1932. 1 adult and 2 young.

COMANTHUS TIMORENSIS

Alecto timorensis J. MÜLLER, 1841. Monatsb. Preuss. Akad. Wiss., p. 186.
Comanthus timorensis A. H. CLARK, 1931. Crinoid Monog., **1**, pt. 3, pp. 159 and 603.

Probably the commonest multibrachiate crinoid on the tropical coasts of Australia, this fine species shows almost as great diversity in color and appearance as does *Comanthina belli*. Adult specimens are not hard to recognize but young and half-grown specimens are easily confused with *parvicirra*. The very young specimens listed below are included under *timorensis* because they appear to be young Comanthus of some species and the present species is most likely to be the one to which they belong. No specimen of Comanthus under 80 mm. across can be identified specifically with certainty unless it is one of a series which connects up with unmistakable adults. The smallest specimen at hand is from Darwin and is only about 10 mm. across, probably 15 mm. in life; there are but 10 arms and there are no division series. The cirri, IX, 9, are short and weak and quite like those of young *timorensis*. Small specimens from Broome, 30–40 mm. across have 11–13 arms and a very good specimen from Darwin about 70 mm. across has 16 arms with 6 II Br 4 series; the cirri are typical, XI, 11. My field notes say of this individual: "Very active, both creeping and swimming. A handsome light brown and white."

The large specimens offer no features of special interest, but it may be mentioned that a particularly good one from Darwin with 32 arms has no fewer than 9 III Br 2 series. From Cape Leveque are two large specimens with 48 and 52 arms and no cirri; in the larger one every division series is 4 (3 + 4). A very large specimen from Broome has only 43 arms but they are about 140 mm. long, and it has cirri XV, 10–13. One specimen from Broome, about 150 mm. across in life, has but four rays; there are 33 arms and every division series is 4 (3 + 4). As for color, little need be said; preserved material is all brown of some shade, ranging from very light in the little individuals to very dark, almost black in some of the larger specimens. But in life the colors were diversified and often very handsome. One taken at Darwin was "black with each pinnule tipped with yellow-green." At Broome my notes say "usually dark but range from green at one extreme to yellow-brown at the other."

There are 28 specimens in hand from the following localities:

Queensland: Capricorn group, Norwest Islet. 1 poor adult. Loaned by Australian Museum.
Northern Territory: Darwin, near jetty, 7 fms., mud, July 1, 1929. 1 very young specimen. Identification ?
Darwin, near Shell Islands, 5 fms., July 25, 1929. 1 very fine adult.
Darwin, near Leper Station, 3–5 fms., May 25, 1932. I young specimen.
Western Australia: Cape Leveque, August, 1929. 3 adults.
Broome, August and September, 1929. 9 adults and 4 very young.
Broome, June, 1932. 7 adults and 1 very young.

Comanthus trichoptera

Comatula trichoptera J. Müller, 1846. Monatsb. Preuss. Akad. Wiss., p. 178.
Comanthus trichoptera A. H. Clark, 1909. Zool. Anz., **34**, p. 363.

It was an interesting experience to find this little comatulid, typical of the temperate waters of southern Australia, living among the corals at Neds Beach, Lord Howe Island, with many echinoderms characteristic of the Great Barrier Reef. It seems to have become well established there but does not grow to a large size. The largest taken were about 125 mm. across but most were under 100 mm. The arms are noticeably more slender than in large specimens from Port Jackson. In life the Lord Howe specimens are "variegated white and brown of various shades, mostly yellowish." They resemble very closely specimens taken in November, 1929, at Port Willunga, South Australia. The cirri are small with usually 13 or 14 segments, seldom 15–17, but the specimens from Port Willunga are not essentially different in this particular, though the number of segments will probably average one or two more in the South Australian material. In his key to the species of Comanthus, subgenus Cenolia, (1931, p. 530) Mr. Clark says of *trichoptera:* "cirri with about 20 segments," in contrast with "cirri with 14–17 segments" in allied species. My material shows 13–17 segments as the rule, only in the largest individuals of *trichoptera* do I find 20 and occasionally 21.

The number of arms in the Lord Howe specimens is usually under 30, the largest having 27 or 28, but there is one with 30 and one with 33. The largest specimen in the present series is from Port Jackson and has 31 rather stout arms, about 75–80 mm. long. A much smaller specimen from Port Willunga has 37 arms. From Bunker's Bay, W. A., there is a specimen with rather stout arms nearly 90 mm. long but there are only 21, while another specimen from the same lot has 28 arms though they are little over 50 mm. long.

The occurrence of *trichoptera* at Lord Howe Island extends the range of the species several hundred miles to the east. It was, therefore, interesting to find a specimen among the echinoderms from Dongarra, W. A. given to me by Professor E. W. Bennett, extending the known range several hundred miles to the northwest.

The 71 specimens at hand were collected at the following places:
Lord Howe Island, Neds Beach, among corals, 18 specimens.
New South Wales: Port Jackson, Bottle and Glass Rocks, November 27, 1929. 2 large adults.
: No definite locality. 1 adult. Loaned by Australian Museum.
South Australia: Port Willunga, November 2, 1929. 10 specimens.
Western Australia: Albany, under stones below low tide mark, January 10, 1929. E. W. Bennett leg. 8 specimens young.
Cape Naturaliste, east side, Bunker's Bay, under stones, January 15–17, 1930. E. W. Bennett leg. 26 specimens, adult and young.
Bunbury, Koombana Bay, 5–8 fms., October 26, 1929. 2 specimens, young.
Cottesloe Beach. 3 specimens, adult and young.
Dongarra. E. W. Bennett leg. One specimen, young.

ZYGOMETRIDAE

ZYGOMETRA COMATA

A. H. CLARK, 1911b. Mem. Austral. Mus., **4**, p. 762, footnote.

This is a common species at Broome and a considerable series was brought home. Mr. A. H. Clark gave me great assistance in determining them, certain individuals being very puzzling. The number of arms ranges from 11 in a specimen 70 mm. across, to 25 in a specimen 115 mm. from tip to tip; the largest specimens are 175–200 mm. across and have from 16 to 24 arms. The colors are yellow and purple but the relative amounts of the two, their distribution and the shades show infinite variety. The shades range for the yellow from almost white to deep buff and for the darker color from light grayish-purple to a very deep, rich, reddish purple. The color arrangements are too diversified to warrant description but it is common to have the arms banded either broadly or narrowly; often the pinnules only are banded and the dorsal side of the arms is prettily mottled or simply unicolor.

It is hard to see how and where the line is to be drawn between this species and *punctata* which was described the following year. So far as the number of segments in the cirri is concerned, the series of specimens from Broome shows that there is a considerable range but only a few large specimens show as many as 25–27, while Mr. Clark says (1918, p. 59) "more than 25 (usually about 30) cirrus segments" in *comata*. Most of the present specimens have 20–23 which accords with the "less than 25" given for *punctata* (1918, p. 60) but not with the "(18–21)" which is added. None of the Broome specimens have fewer than 20 segments.

Although not previously recorded from northern Australia, this comatulid is very common at Broome. Like all the Zygometras of that region, it delights in the clean shallow water and hard sandy bottom of Roebuck Bay. At extreme low water in the greatest spring tides (as in September, 1929) a large part of the water ebbs out of Roebuck Bay and vast areas of a clean, firm gray sand are exposed. On this bottom are countless patches or isolated plants of coralline and other algae, besides partly buried rock fragments or shells scattered abundantly about, well separated from each other, and each forming the nucleus of a little animal community seeking shelter from the pitiless exposure to which the unusual ebb of the tide subjects them. On almost every alga or other projection, a comatulid will be found (usually but one) and the vast majority of these are Zygometras and chiefly *comata*. It is a hardy species, enduring this exposure to the sun, transferring to a bucket and transportation to the laboratory without damaging itself in any way. Left by the retreating tide, the comatulids fall relaxed on their sides, the arms closed on the disk and pointing to the water that has abandoned them, but when the tide returns, enduring for a time the washing back and forth of the now coming, now going wavelets, they soon find the water deep enough to enable them to sit erect, expand their arms and renew their normal life. Seeing this flower-like expanding of the wilted comatulids is one of the most interesting pleasures of watching the incoming tide.

The 39 specimens of *comata* at hand were all taken in or near Roebuck Bay in 1929 and 1932, excepting two which were secured in the vicinity of Lagrange Bay in 1929.

ZYGOMETRA ELEGANS

Antedon elegans BELL, 1884. "Alert" Rep., p. 162.
Zygometra elegans A. H. CLARK, 1907. Smithson. Misc. Coll., **50**, p. 348.

This is another very common comatulid at Broome, occurring under the same circumstances as *comata*, with large specimens of which small specimens of *elegans* might be confused. It is, however, a larger but more delicate species, with more arms and many more cirrus segments. It is hard to see why Gislen (1919, p. 19) treated *elegans* as merely a variety of *microdiscus* but I suspect (from his description) that the individual which he describes as *microdiscus* was really a large *elegans* with the maximum number of arms and of cirrus segments. The large series of specimens at hand from Broome show well the following differences between the two species:

Division series: in *elegans*, III Br 2, with few series beyond, and those often 2.
in *microdiscus*, III Br 4, and the many subsequent series almost always 4.
Cirri: in *elegans* XX-XXX, 34–56, usually under 45.
in *microdiscus* XXVII-XLIII, 35–70, usually over 45.
Lowest pinnule in *elegans* not nearly so flagellate as in *microdiscus* and smaller in every way.
Color in *elegans* is more varied on the whole, combinations of light grays, buffs, fawn-color and purple of various shades being usual while unicolor specimens are rare;
in *microdiscus*, deep purples are prevalent and unicolor specimens are common, but handsomely striped and variegated specimens are by no means rare, and are very striking.

The largest specimen has 51 arms about 130 mm. long and the XX cirri have 45–56 segments. A very fine specimen from Darwin has only 36 arms but they are nearly 150 mm. long; the cirri have about 40 segments. In life, according to my field notes on this specimen, "the color was distinctly dull purple and white; disk whitish or pale cream color; pinnules tipped with white and also white on dorsal side." The smallest specimen at hand has 31 arms about 45 mm. long; all of the III Br series are 2. The cirri have 36 segments.

While occurring with *comata* on open sandy bottom, this species also occurs among rocks, and is frequently dredged on bottoms covered with algae, sponges and other marine growths. The 48 specimens before me are from the following places:

Queensland: Capricorn group, off Norwest Islet, 6 fms., December, 1930. Livingstone and Boardman leg. 3 specimens. Loaned by Australian Museum.
Northern Territory: Darwin, near Shell Islands, 3–6 fms. on sponge and alcyonarian bottom, July 2, 1929. 1 very fine adult specimen.
Western Australia: Broome, Cable Beach. September 2, 1929. Frances L. S. Clark leg. 2 fine adults.
Broome, on hard sandy bottom, August and September, 1929. 19 specimens.
Broome, dredged at various points, 3–8 fms., June, 1932. 23 specimens, adult and young.

ZYGOMETRA MICRODISCUS

Antedon microdiscus BELL, 1884. "Alert" Rep., p. 163.
Zygometra microdiscus A. H. CLARK, 1907. Smithson. Misc. Coll., **50**, p. 348.

This truly magnificent comatulid is by no means rare in the Broome region but it is not so common as either of the preceding species and prefers deeper water. Most of the specimens taken were dredged in 5–8 fms. but a very few were found on the hard sandy bottom of Roebuck Bay during the extreme low tides of September, 1929. The color is primarily a reddish-purple or even deep claret with the dorsal surface of the arms more or less yellow, but the amount of yellow varies enormously; at one extreme are individuals which are practically all purple, really unicolor, (and they are not rare) while at the other are those in which the yellow predominates to such an extent that only the tips of the cirri and more or less of each pinnule distally are purple. The most beautiful specimens are yellow or nearly white, finely speckled more or less profusely with purple. In preserved material, even that which is very carefully prepared, the yellow shades become buff or light brown and the purple becomes dingy and often distinctly brown. Naturally such museum material fails to give any adequate idea of the beauty of the living animal. In life, the finest specimens are over 300 mm. across.

In the present series the most interesting are the largest and smallest. The latter taken in Lagrange Bay, has but 19 arms 20–25 mm. long; there are 12 division series, all 4 (3 + 4); the cirri are XIII, 25–29 and relatively very long, more than half as long as the arms; the color is uniformly deep purple. In spite of its small size, this is quite a typical *microdiscus*. The largest specimen, which in its present dry condition is very nearly 300 mm. across was taken in Roebuck Bay. It has about 110 arms but it is impossible to count the exact number without serious damage to the specimen. My field notes say that in life it was "deep claret with dorsal side of arms yellow; some young arms are tipped with white;" at present it is a deep purple, and only distally do the arms show that they were yellow dorsally in life; they are now a light brown dorsally near the tips. The dark purple cirri are XLIII, 52–70, and are 50–55 mm. long; a few of them are cream-color near the base, and one of them is forked at the tip.

The 25 specimens of *microdiscus* at hand were taken as follows:

Western Australia: Broome, August and September, 1929. 6 specimens, 1 very large.
Lagrange Bay, 5–8 fms., September, 1929. 5 specimens, 1 very young.
Broome, June, 1932. 14 specimens, showing great variety in size and color.

HIMEROMETRIDAE

HETEROMETRA CRENULATA

Antedon crenulata P. H. CARPENTER, 1882. Jour. Linn. Soc. London, **16**, p. 507.
Heterometra crenulata A. H. CLARK, 1918. "Siboga" Unst. Crin., p. 77.

Our first capture of this strikingly handsome comatulid came at the close of a long day's dredging outside Roebuck Bay. Our last haul was made in 5–8 fms. on Pearl Shoal and contained half a dozen of what seemed at the moment the most lovely comatulid I had ever seen. The arms were a pure milk white, the cirri bright rose color in sharp contrast. The somewhat rigid arms remained curved outward like the petals of a flower and the old book name "sea-lily" was most appropriate. We subsequently dredged other specimens, whose coloration was so different they were not even suspected of being the same species. In 1932, we met with Heterometra often and the diversity of color led to the supposition that we were collecting three different comatulids. It was a great surprise to discover on critical study here in the Museum that they all represent a single and long known species.

According to coloration, three forms may be recognized but with sufficient material, it is obvious that they intergrade completely. At one extreme are the milk white forms with rose colored cirri already mentioned. When preserved in alcohol or dried, these lose much of their beauty, the white becoming dingy or tinged with purple and oftentimes small spots or blotches of a purplish shade appear. At the other extreme are the individuals, usually large ones which are deep red purple or dark crimson with few or no lighter markings; these commonly have a coarser and more rugged structure than the white ones. The third group comprises the more or less handsome individuals with banded arms; these may be white, or at least very light, as to ground color with the arms banded with red or purple of some shade, or they may be red or purple with whitish bands and markings. The number, width and shade of armbands show endless diversity. The cirri are always red or purple of some shade, ranging from light rose to a deep red violet.

One very small comatulid, apparently a Heterometra, and hence almost surely this species, was taken in 1932. There are but 13 arms, about 15 mm. long; the division series are 4 (3 + 4) but the cirri are only X, 13; the color is very pale brown, the cirri with a very slight tinge of violet. The number of arms in the present series of *crenulata* ranges from 16 to 30 but the great majority of individuals with arms over 60 mm. long have 20–25. The cirri are XX-XXXII, 34–46, but small individuals often have fewer segments. The largest specimens have the arms 75–90 mm. long. There is great diversity in the development of the projections on the segments of the basal pinnules; often they may best be designated as spines but in other cases they must be characterized as "wings;" light colored individuals seem on the whole to tend towards wings, while the dark colored ones are more spinous; the correlation is, however, very imperfect.

The 50 specimens at hand were taken as follows:

Queensland: Capricorn group, Norwest Islet, 6 fms., December, 1930. Boardman and Livingstone leg. 2 specimens. Loaned by Australian Museum.

Western Australia: Broome, on or near Pearl Shoal, 5–8 fms., September, 1929. 18 specimens, adult and young.

Broome, dredged at various points in 5–8 fms., June, 1932. 30 specimens, adult and young.

AMPHIMETRA JACQUINOTI

Comatula jacquinoti J. MÜLLER, 1846. Monatsb. Preuss. Akad. Wiss., p. 178.
Amphimetra jacquinoti A. H. CLARK, 1918. "Siboga" Unst. Crin. p. 85.

This stiff and rather ungainly comatulid is by no means common at Broome but we met with it several times while dredging, and one specimen was found at extreme low water in September, 1929. These individuals are all adult with the ten arms 110–130 mm. long. The cirri are XV-XXX, 28–36. The color in life was deep reddish purple, becoming very dull on drying; the arms are more or less marked or banded with white or yellow, but the location and amount of the light color show great diversity; sometimes it is confined to the pinnules, or to the dorsal side of the tips of the arms, or to regenerating portions of injured arms.

The 10 specimens in the present collection were taken as follows:

Western Australia: Broome, about one mile off jetty, August 27 and September 5, 1929. 2 specimens.
Broome, off Gantheaume Point, 2–4 fms., August 30, 1929. 3 specimens.
Broome, 5–8 fms., June, 1932. 5 specimens.

MARIAMETRIDAE

LAMPROMETRA GYGES

Antedon gyges BELL, 1884. "Alert" Rep., p. 160.
Lamprometra gyges A. H. CLARK, 1913. Proc. Biol. Soc. Washington, **26**, p. 144.

This many-armed comatulid is common on the tropical coasts of Australia and its diversity of color and of arm length make it a very perplexing species, and I am not at all convinced that several different species are not included under Bell's specific name. On the other hand the supposed distinction between *gyges* and *protectus* (Lutken) is based on a very variable character and the line is hard to draw. For the present, however, regardless of their differences, I am including all of my Mariametridae under the one name, hoping that at some future time critical study of more material may satisfy my present doubts.

The material before me consists of 24 specimens ranging from a young one with only 19 arms, 20–25 mm. long and with cirri XV, 14–15, up to fine adults with 45–51 arms, 70–100 mm. long, and with the cirri XXXVIII–XLVIII, 26–30. Most of the specimens are gray or brown of some shade and apparently unicolor, but a few of the lighter colored ones seem to have had a broad whitish band on the arms in life. Unfortunately these Lamprometras did not attract my interest at the time of their capture sufficiently to receive the attention they deserved and my field notes are confused and inadequate. It is greatly to be regretted that the very rich collecting at Broome and the enthusiasm and industry of Mr. Bourne and his crew often swamped me with specimens to be cared for, and left time for only very meagre notes.

The 24 Lamprometras at hand were taken as follows:

Northern Territory: Darwin, near Shell Islands, 3–6 fms., sponge and alcyonarian bottom, July, 1929. 5 specimens, young.
Western Australia: Broome, August and September, 1929. 6 specimens, adult.
False Cape Bossut, September, 1929. 1 specimen, adult.
Broome, June, 1932. 12 specimens, adult, large and small.

COLOBOMETRIDAE

PETASOMETRA BREVICIRRA[1] sp. nov.

Centrodorsal thin, discoidal with a broad flat dorsal pole, about 3 mm. across; cirrus sockets in a single closely crowded marginal row. Cirri XXI, 18–22, about 9 mm. long, somewhat recurved (fig. 1); cirrus segments sub-equal in length but, when seen from below, 4 and 5 are much the widest, 3 and 6 somewhat narrower, 2 and 1 are about equal or 1 is narrower; beyond 6 the segments decrease slightly but steadily in width until the terminal segments are no wider than long; the dorsal transverse ridge, characteristic of the genus, is present near the middle of each segment but is not well marked until after the fifth and never becomes spiniform until the penultimate segment on which the opposing claw is fairly well developed.

Radials concealed; I Br well developed, the width about two and a half times the length; axillaries large, broadly pentagonal, the width not twice the height; there are four II Br 4 (3+4) series and one II Br 2; the division series are all well rounded and except for the proximal half of the first elements, distinctly separated from each other. There are 15 arms, 45–60 mm. long; the first brachials are noticeably rounded, somewhat higher externally than internally where they are in contact for one-half their length or more; second brachial very similar and the two together are somewhat higher than 3 and 4 which are united by syzygy; brachials 3–7 are as high on one side as the other but from the eighth on they are more wedge-shaped though they never become nearly triangular; the second syzygy occurs after an interval of about 13 brachials and the following after about 8.

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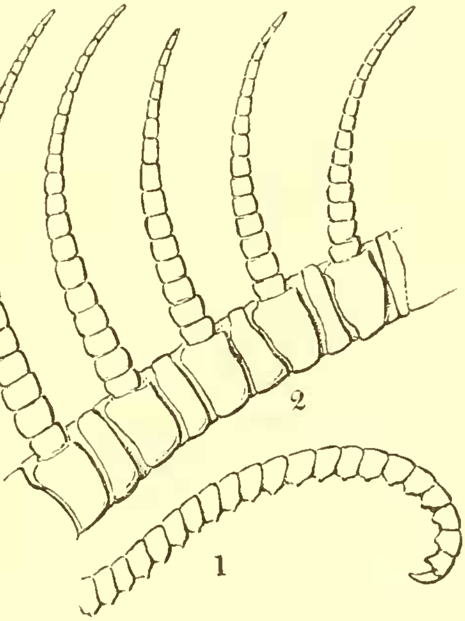
[1] *brevis* = short + cirrus, in reference to the characteristic cirri.



Figs. 1 and 2. Petasometra brevicirra: 1, a cirrus; 2, pinnules p_1—p_5. x 8.

P_a absent; P_d about 8 mm. long, rather stout, with about 20 segments, the distal portion is terete and slender but by no means flagellate or even delicate; the basal segments are about as wide as long and relatively large but diminish rapidly in size. P_1 (fig. 2) is very similar, a trifle longer perhaps, with about 23 segments. P_2 is similar but a little smaller. P_3 is distinctly smaller with about 15 segments but the transition from P_2 to P_3 is not abrupt or striking; subsequent pinnules not essentially different but ultimately become longer and more slender; as they increase in length the number of segments rises again to exceed 20. The margins of the pinnule segments are uniformly smooth.

Color (of dry specimen) light purplish-brown, the joints between the brachials conspicuously darker; distally the dorsal surface of some arms is evidently purple; centrodorsal dark purplish brown; cirri at base dorsally, deep buff but passing into purplish-brown on ventral side and distally; a broad band of dull dark purple on each side of each cirrus, near the dorsal side, becomes narrow distally and fades away at the penultimate segment; disk light colored, except the anal cone which is very dark.

Holotype, M. C. Z. No. 916, from False Cape Bossut, Western Australia, September 9, 1929.

The peculiarities of this unique specimen were not noted at the time of capture, and no special field notes are connected with it. It is apparently a Petasometra but the short cirri with few segments and the short, rather rugged pinnules set it apart from the previously known species, while its whole appearance is strikingly different from the following species. It seems strange that in all the collecting of June, 1932, no further examples of Petasometra were taken.

PETASOMETRA VARIEGATA[1] sp. nov.

Centrodorsal thin, discoidal with a broad slightly concave dorsal pole, over 3 mm. across; cirrus sockets in a single closely crowded marginal row. Cirri about XXIII, 22–25, 11 mm. long, markedly recurved (fig. 3); cirrus segments very short and wide proximally but becoming narrower and even compressed distally, with little change in length; the basal segments are twice as high as long but the distal ones are not much higher than long; the dorsal transverse ridge is present from the second segment on but it is never very conspicuous and even the opposing claw may be rather small, though it is usually well-marked.

Radials concealed; I Br well developed but low, the width about four times the length; axillaries also low, the greatest height hardly one-third of width, the anterior angle rounded and the adjoining sides slightly concave; there are seven II Br 4 (3+4) series and three II Br 2; there are nine III Br 4 (3+4), one III Br 2 and one III Br 5 (4+5) series. There are thus 31 arms, which are relatively short and stout; all are more or less damaged but they were apparently not over 80 mm. long (perhaps 100 mm. in life); the division series are all rather rugged and stout, more or less in contact and the II Br series is a little inclined to be swollen; the brachials are wide and low about twice as wide as long; beyond the seventh or eighth they become wedge-shaped; the first syzygy is between 3 and 4, the second between 11 and 12, and subsequently at intervals of 6–8 brachials.

P_a absent; P_d not more than 10 mm. long, rather stout with 20–23 segments; distal portion tapers rapidly to a terete but by no means slender tip; basal seg-

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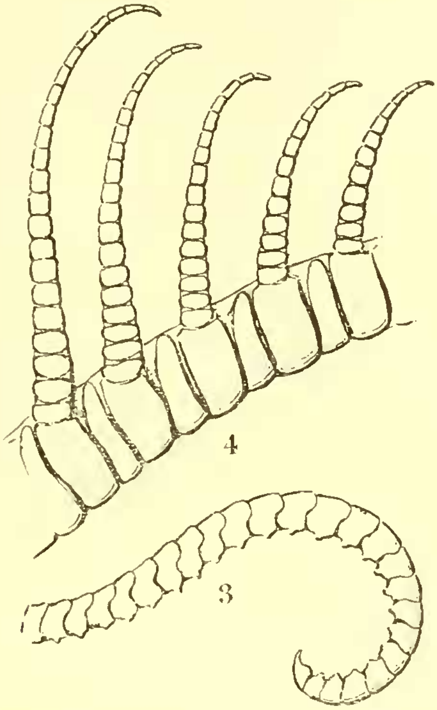
[1] *variegatus* = variegated, in reference to the handsome black and white coloration.

ment large, oblong, wider than high; second more nearly square and considerably smaller; third and following segments successively smaller and becoming cylindrical; margins all smooth. P_1 (fig. 4) is very similar and scarcely longer. P_2 is similar but a trifle smaller and with fewer segments. P_3 is distinctly smaller and P_4 much smaller and with only about a dozen segments; succeeding pinnules small but soon increasing in length and number of segments until distally there are again more than 20 in each pinnule but they are all small.



Figs. 3 and 4. Petasometra variegata: 3, a cirrus; 4, pinnules, p_1—p_5. x 8.

Color (of alcoholic specimens) very dark brown, almost black, variegated with cream-color; many arms are almost white dorsally, at least on distal half, but not the pinnules; many cirri are white dorsally and ventrally but blackish on sides.

Holotype, M. C. Z. No. 917, from near Shell Islands, Darwin, N. T., 3–6 fms., sponge and alcyonarian bottom, July 15, 1929.

A second specimen was taken at the same time and place but is somewhat smaller, has only 19 arms, 70–80 mm. long, with eight II Br 4 series and one II Br 2. The first syzygy is between brachials 3 and 4, but the next is far out on the arm beyond the thirtieth brachial, and there are very few all together. The cirri are XX, 22–24, short, thick and strongly recurved. This paratype is dry and the color is dull gray brown, variegated and spotted with a light yellow-brown; there is much less of the light color than in the holotype.

My field notes say of these specimens that "they seemed almost black with dorsal side of arms cream-white. Very handsome. Died on way home and never relaxed, hence are poor specimens."

In several points this handsome species suggests *Antedon clarae* Hartlaub and I have tried to convince myself that it should be called by that name, but the type of that East Indian form was much larger than the Darwin specimens, yet had only 12 arms. It also had much longer cirri and the colors and color pattern were totally different. It seems best, therefore, to keep the Australian species separate.

AUSTROMETRA THETIDIS

Oligometra thetidis H. L. CLARK, 1909. Mem. Austral. Mus., **4**, p. 522.
Austrometra thetidis A. H. CLARK, 1918. "Siboga" Unst. Crin., p. 111.

This little comatulid is represented in the present collection only by three dry specimens belonging to the Australian Museum which were taken in December, 1929, west southwest of Gabo Island, N. S. W.; they were trawled in 70 fms. by Captain K. Moller, who presented them to the Museum. They are somewhat smaller than the types but are otherwise similar; one is cream color, one is suffused with a reddish-violet tint and the third is distinctly light reddish-violet with indistinct small areas of cream color.

OLIGOMETRIDES ADEONAE

Comatula adeonae LAMARCK, 1816. Anim. s. Vert., **2**, p. 535.
Oligometrides adeonae A. H. CLARK, 1913. Smithson. Misc. Coll., **61**, no. 15, p. 37.

This species has already been recorded from Broome and vicinity by Gislen (1919) who has discussed his specimens with great care, so it is not necessary for me to go into details. We did not find *adeonae* at Darwin or at Cape Leveque, perhaps because local conditions are not favorable. It is one of the commonest of the small comatulids in the Broome region and we met with it constantly. It was particularly common and easy to collect (along with *Zygometra comata*), at the extremely low September tides in 1929, on the hard-sand bottom of Roebuck Bay. My field notes say: "Very lovely: deep red-purple, with or without white." "Deep red-violet and white." "Sometimes apparently deep yellow, with or without white on basal pinnules." Alcoholic specimens keep their colors very well. Dry specimens are duller and show no white but instead are various shades of yellow and pale brown. Practically all gradations may be found between the purple and the yellow individuals.

The most interesting specimen at hand is one with 11 arms, a single II Br 2 series being present; there are no other notable peculiarities, except perhaps that it is the most conspicuously yellow of all the specimens preserved. Another notable specimen, with arms 75–80 mm. long, has one arm which gives off a branch at almost right angles, in the vicinity of the 18th brachial; just one or two brachials further on the main arm forks and three brachials further the left hand arm forks again. This individual therefore has, distally, 13 arms.

The largest specimens have arms about 90 mm. long and the cirri are XXX–XXXII, 28–30, while the smallest individuals have arms about 35 mm. long and the cirri XVI–XIX, 16–21.

The 61 specimens before me were taken as follows:

Western Australia: False Cape Bossut, September, 1929. 3 specimens.
Broome, August and September, 1929. 40 specimens.
Broome, June, 1932. 18 specimens.

CALOMETRIDAE

Neometra gorgonia

A. H. Clark, 1914. Records W. A. Mus., **1**, p. 125.

Through the kindness of Mr. Glauert one of the paratypes of this striking species is before me, apparently either No. 5 or 6 of Mr. Clark's list. All the arms are broken but more than 36 and probably 40 were present; there are two IV Br series. There are 10 cirri (all broken) and 13 sockets on the margin of the large flat centrodorsal. The locality where this and all other known specimens of *gorgonia* were taken, is between Fremantle and Geraldton, 80–120 fms.

APOROMETRIDAE, fam. nov.

APOROMETRA[1] gen. nov.

Arms 10, relatively short, with comparatively few brachials and pinnules, but numerous syzygies. Centrodorsal low hemispherical completely covered with cirrus sockets and two or more marginal series of cirri. Cirri rather numerous, up to XXV, with very numerous short, wide segments, stout at base but tapering

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[1] ἄπορος = *with no way through, difficult to find the way,* hence *puzzling,* + *metra,* the widely used termination for comatulid genera.

gradually to a slender, somewhat flattened, recurved or loosely coiled tip; there are no spines, ridges or tubercles, except a very insignificant "opposing tubercle" on the penultimate segment. Disk thinly but more or less completely plated. First pinnule large, conspicuous and rather stiff, but with only about 10 segments; second pinnule much smaller and flexible, sometimes the smallest pinnule on the arm.

Genotype, *Himerometra paedophora* H. L. Clark.

The discovery at Bunbury of a second species of this peculiar genus has led to critical study of its characters by both Mr. Austin H. Clark and myself. We had previously disagreed radically as to its status, but are now in complete agreement. I am very grateful to Mr. Clark for his careful attention to this matter and especially appreciate his frank acknowledgment of the validity of the genus and the necessity of making a new family for its reception.

So peculiar are the characters of this family that Mr. Clark says (*in litt.*) "trying to figure out its proper systematic position has been one of the most perplexing puzzles I ever tried to solve." He has finally concluded that Aporometra is nearer to Notocrinus than to any other genus, that each is unique in its own family, and that the two families form a separate suborder, the Notocrinida. "The most satisfactory disposition of the Notocrinida would seem to be to consider it as a suborder within the Oligophreata, equivalent to, and on the same basis as the Comasterida, Mariametrida and Tropiometrida."

It needed but slight comparison of the specimens from Bunbury with those from the coast of New South Wales to show that they are not the same species, but the possibility that one or the other was identical with the comatulid from Victoria described by Bell in 1888 as *Antedon wilsoni* required consideration. Thanks to the kindness of Mr. D. Dilwyn John, an exchange was effected with the British Museum by which two cotypes of *wilsoni* came to the M. C. Z. Comparison of these with the other material at hand was made independently by Mr. A. H. Clark and myself and we quite agree that there are at least three species of Aporometra now known from the southern coasts of Australia. These may be distinguished from each other as follows:

Key to the Species of Aporometra

A. Longest cirrus segments half again as long as broad. (Port Philip, Victoria)..... *wilsoni*

A¹. Longest cirrus segments not longer than broad.
  Cirri with 25–35 (usually 28–30) segments of which most are about as long as broad. (New South Wales)........ *paedophora*
  Cirri with 39–61 (usually 40–50) segments of which even the longest are distinctly broader than long. (Southern Western Australia)........ *occidentalis*

APOROMETRA OCCIDENTALIS[1] sp. nov.

Centrodorsal hemispherical or rounded conical, often more or less flattened, with cirrus sockets arranged in about 10 columns of 2–4 each. Cirri about XX, 39–61 but usually 40–50, 20 mm. or more in length when fully developed nearly or quite equalling the arms; basally the segments are about twice as wide as long but distally, tho they become somewhat flattened, the width is relatively less; there are no projecting spinelets, tubercles or ridges distinct enough to be mentioned, except a minute opposing tubercle on the penultimate segment; the cirri taper very noticeably on the distal half and are frequently recurved or even coiled at the tip.

Radials barely visible, the distal border slightly concave; IBr_1 about three times as broad as long; axillaries broadly rhombic about twice as wide as long. Arms 10, some 25–28 mm. long. First brachials about twice as long exteriorly as interiorly, approximately twice as broad as the external length; second brachials similar but with distal borders more oblique; brachials 3 and 4 united by syzygy; next two brachials about twice as broad as long but with oblique ends; the following brachials similar, commonly alternating with syzygial pairs; distally the brachials are distinctly broader than long.

P_1 is 7.5 mm. long with about 14 segments, smooth, somewhat flexible, tapering evenly from a rather stout base to a slender but not delicate tip; fourth and following segments about 3 times as long as thick. P_a is similar but little more than half as large and has only 10 segments. P_2 is only 3 mm. long, with 11 segments, slightly longer than broad; the pinnule is rather stout basally, the third, fourth and fifth segments supporting a large ovoid gonad; the following pinnules to P_8 are similar but slightly longer; after P_{14} there is no evident gonad; distal pinnules 3.5 mm. long with 12–14 segments, the terminal ones being minutely rough with recurved spinelets and tubercles. Color in life as described beyond.

Holotype, M. C. Z. no. 964, from Koombana Bay, Bunbury, W. A., 5–8 fms.

Perhaps the most rewarding feature of the excursion made by Professor E. W. Bennett and myself to Bunbury in October, 1929, was the discovery that this little comatulid is abundant in that vicinity. It was, therefore, possible to secure enough material to completely validate the genus and establish the species. (Michaelsen and Hartmeyer had secured three specimens in Koombana Bay in

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[1] *occidentalis* = western, in reference to its geographical occurrence on the Australian coast.

1905 but when A. H. Clark reported on their collection of crinoids, he considered these little comatulids as "very young" *Ptilometra macronema,* and listed them accordingly.)

While dredging in 5–8 fms. in Koombana Bay, October 26, 1929, one or two miles west of the breakwater, Bennett and I found comatulids very common, and easily recognized three species; the largest proved to be *Comatulella brachiolata,* a much smaller and more delicate species was *Compsometra incommoda,* and the third and most common, was the present form. We preserved a large number of specimens, of which 148 are at hand. In alcohol they have undergone practically no change of appearance but the dry ones are paler and more rigid, of course. The color of the oral surface is always brown, usually very dark, the disk being marked more or less with whitish; the dorsal side of arms and calyx is brown, ranging from a distinctly yellowish, to a deep, somewhat purplish shade; the cirri are often purplish, brownish or even reddish but are generally very light and often almost white, in rather marked contrast to the arms, which they sometimes nearly approximate in length or even exceed. These cirri are efficient "holdfasts," admirably adapted to the bottom on which the comatulids were living, for this was covered, more or less, with algae (chiefly Cystophora) and other vegetation (chiefly Cymodocea). The dredge came up full of these plants and the various comatulids (not to mention other echinoderms) were well tangled with them and with each other by means of the long, recurving cirri of this species. It is worthy of note that we did not find Ptilometra at Bunbury — nor at any other point on the Australian coast, which seems a bit odd.

The smallest specimens of Aporometra which we took at Bunbury were hardly 20 mm. across; the longest of the dozen cirri are about as long as the arms (say 8–10 mm.) and have some 35 segments. The largest specimens have the arms 25–30 mm. long and the longest of the 20–25 cirri are but little shorter; they have more than 50 segments of which the terminal dozen are very small. There are only 20–25 pinnules on each side of the longest arms.

The most interesting biological fact about this comatulid is that it is viviparous; that is to say, the eggs are not shed from the genital pinnules but undergo their development in and on them. The original specimens from which the species *paedophora* was described, carried pentacrinid larvae in various stages of growth borne on the pinnules. Those individuals were collected in late summer or early fall (February and March). The specimens taken in Koombana Bay in late spring have the genital pinnules with large eggs and young embryos, not yet pentacrinids. Each pinnule seems to have 4 or 5 eggs but usually if development is well under way there are but 3 or 2 embryos. I suspect that only one pentacrinid develops on each pinnule, the other eggs and embryos serving as nourishment for its growth. The whole life history could be easily worked out at Bunbury during a summer, I have little doubt, and would be a very interesting and valuable study. It is possible that the work could be done at Fremantle, for besides the Bunbury material, I have 3 small specimens of this comatulid labelled as taken near Garden Island in 1929, which were given to me by Professor Bennett.

ANTEDONIDAE

COMPSOMETRA INCOMMODA

Antedon incommoda BELL, 1888a. Ann. Mag. Nat. Hist., (6), 2, p. 404.
Compsometra incommoda A. H. CLARK, 1911b. Mem. Austral. Mus., 4, p. 792.

This little comatulid is found all along the western coast of Australia as far north at least as Geraldton. The specimen taken there is a rather small but quite typical individual which we found in a little tide-pool on the rocky shore north of the town. It seemed a most unlikely place for a comatulid for there was little animal life in those particular tide-pools.

The 59 specimens at hand were taken at the following points:

Western Australia: Geraldton, tide-pool north of jetty, October 7, 1929. 1 specimen, young.
Dongarra. E. W. Bennett leg. et don. 9 specimens, young.
Cottesloe, North Beach. L. Glauert leg. et don. 1 specimen, young.
Fremantle, off Garden Island, 7 fms., October, 1929. 8 specimens.
Bunbury, Koombana Bay, 5–8 fms., October 26, 1929. 6 specimens.
Bunbury, Basalt Reef, September 28, 1930. E. W. Bennett leg. et don. 1 specimen, young.
East of Cape Naturaliste, Bunkers Bay, January 15–17, 1930. E. W. Bennett leg. et don. 17 specimens, mostly young.
Albany, under stones below low water mark, January 10, 1929. E. W. Bennett leg. et don. 16 specimens, young.

Compsometra loveni

Antedon loveni Bell, 1882. Proc. Zool. Soc. London, p. 534.
Compsometra loveni A. H. Clark, 1908. Proc. Biol. Soc. Wash., **21**, p. 131.

There are 79 specimens of this well-known comatulid in the collection at hand, including both adult and young. They were all dredged in Port Jackson, near Middle Head, in 4–5 fms., on November 21, 1929.

Dorometra parvicirra

Antedon parvicirra P. H. Carpenter, 1888. "Challenger" Comat., p. 204.
Dorometra parvicirra A. H. Clark, 1917. Jour. Wash. Acad. Sci. **7**, p. 128.

This delicate little comatulid is apparently not rare in Port Darwin, as we met with it in both 1929 and 1932. There is great diversity of color, ranging in life from "a handsome light brown and white" (in the dry specimen the brown has become a rather faint gray-brown) to "fine black, white and cream-color . . . the finely variegated arms defied description." Another is described as "dull blackish with not very evident yellowish markings on pinnules and arms;" this specimen is now dull purple with cirri and pinnules and irregular markings on arms, nearly white. Specimens preserved in alcohol are yellowish-brown or pale brown with cirri and pinnules whitish. In spite of this wide diversity in color, all of the Dorometras at hand seem to represent but a single form and the resemblance to Carpenter's *Antedon parvicirra* from the Philippine Islands is so close, it seems best to refer them to that species.

The largest specimen, the dry, light-colored one mentioned above, has the arms 50–60 mm. long and 10 mm. across the widespread pinnules; the cirri are about XXX, 12–14, and the pinnules are those characteristic of the species; the first small, slender with 10–12 segments, the second somewhat longer and the third much longer and larger; the tips are broken on the pinnules so that it is not possible to give the exact number of segments, but the second has at least 13 and the third at least 18.

A small Dorometra from an island north of Cooktown, Queensland, was given to me at Hobart, Tasmania, by Professor T. T. Flynn, and a critical examination shows no good ground for not calling it *parvicirra*. The range of this comatulid is thus extended far to the south, adding one more species of echinoderm to the rich Barrier Reef fauna.

The 6 specimens of *parvicirra* at hand are from the following localities:

Queensland: Eagle Island, Great Barrier Reef, north of Cooktown. T. T. Flynn leg. et don. 1 specimen.
Northern Territory: Darwin, near Shell Islands, 3–6 fms., July, 1929. 4 specimens.
Darwin, near Leper Station, 3–5 fms., bottom covered with coralline algae, broken coral, sponges and alcyonarians, May 25, 1932. 1 specimen.

MONILIMETRA[1] gen. nov.

Similar to Dorometra in most characters but distinguished by the more or less moniliform first pinnules, which are shorter and much more slender than the second and third.

Genotype, *Monilimetra nomima* sp. nov.

This little group of species, known as yet only from the vicinity of Broome presents a curious analogy to the West Indian genus Coccometra, as has been pointed out to me by A. H. Clark. For Coccometra contains three closely related species known as yet only from the northwestern part of the West Indian region and they are characterized by the moniliform first pinnule. But Coccometra and the related Thysanometra of the northeastern part of the East Indian region differ strikingly from Monilimetra in the much longer and more slender cirri and first pinnules. The new genus is, I believe, much nearer to Dorometra than to the Thysanometrinae.

There seem to be four quite different forms of Monilimetra in the Broome region, which may, for the present at least, be considered distinct species. It is not improbable that more abundant material will show a greater intergradation than the present available specimens indicate. The four species may be distinguished as follows:

Key to the Species of Monilimetra

A. Cirrus segments 4–6, not conspicuously different from the others, rather stout, slightly compressed, not twice as long as thick; color of arms dorsally, brown of some shade or yellowish or whitish, often more or less variegated with purple or dusky and light shades.

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[1] *monile* = a necklace + *metra*, the widely used termination for comatulid names, in reference to the moniliform first pinnule.

B. Normal mature cirri short, with 13–15 segments, the basal ones not much compressed; pinnules unicolor or at any rate not handsomely banded.

Fourth pinnule very large, nearly or quite equalling the third; first pinnule conspicuously moniliform with more than 23 segments; color brown of some shade, sometimes variegated, sometimes very light . . . . *nomima*

Fourth pinnule obviously smaller than third; first pinnule moniliform only in basal half, with fewer than 23 segments; color light, faintly mottled with dusky, sometimes with a broad longitudinal blackish stripe on dorsal side of arms . . . . . *lepta*

B². Normal mature cirri with 16–18 segments, all rather short, compressed though not markedly so, proximally; pinnules handsomely banded purple and white . . . . *poecila*

A¹. Cirrus segments 4–6 elongated, more than twice as long as the diameter of the nearly cylindrical middle; color purple and white; cirri pure white (except sometimes basally); arms usually deep purple but may be white and only purple on basal pinnules. . . . *bicolor*

MONILIMETRA NOMIMA[1] sp. nov.

Centrodorsal low hemispherical, not quite 3 mm. in diameter, well covered with cirrus sockets except at the pole; those nearest the pole are very small while those near the margin are largest. Only 3 cirri are present and all of these are broken, but one lacks only the terminal claw; this one (fig. 5) has 13 segments, short, wide and, except basally, distinctly compressed; segments 4–6 are longest but are not much longer than distally wide; opposing claw small and inconspicuous. (As shown in two paratypes, the terminal claw is not conspicuous or peculiar, but normally curved.)

Radials concealed; I Br low, its width about 4 times its length; axillaries more or less triangular, with slightly concave sides, their length not quite equal to their width; the synarthrial joints between them and the I Br, and also those of the first brachials with them are not at all close. There are 10 arms of equal size; all are broken but they would not exceed 35 mm. in length, and the number of brachials was probably not more than 70 (counting syzygial brachials as one); the first brachials are low and twice as high on the outer margin as on the inner where they are rather markedly in contact; the width is about equal to twice the height of the outer margin; the second brachials are somewhat higher and the third and fourth (united by syzygy) together equal the second; the succeeding three or four brachials are about twice as wide as high and nearly quadrangular; after that they become more wedge-shaped but never become triangular; syzygies occur between 9 and 10 and then at irregular but usually rather short intervals.

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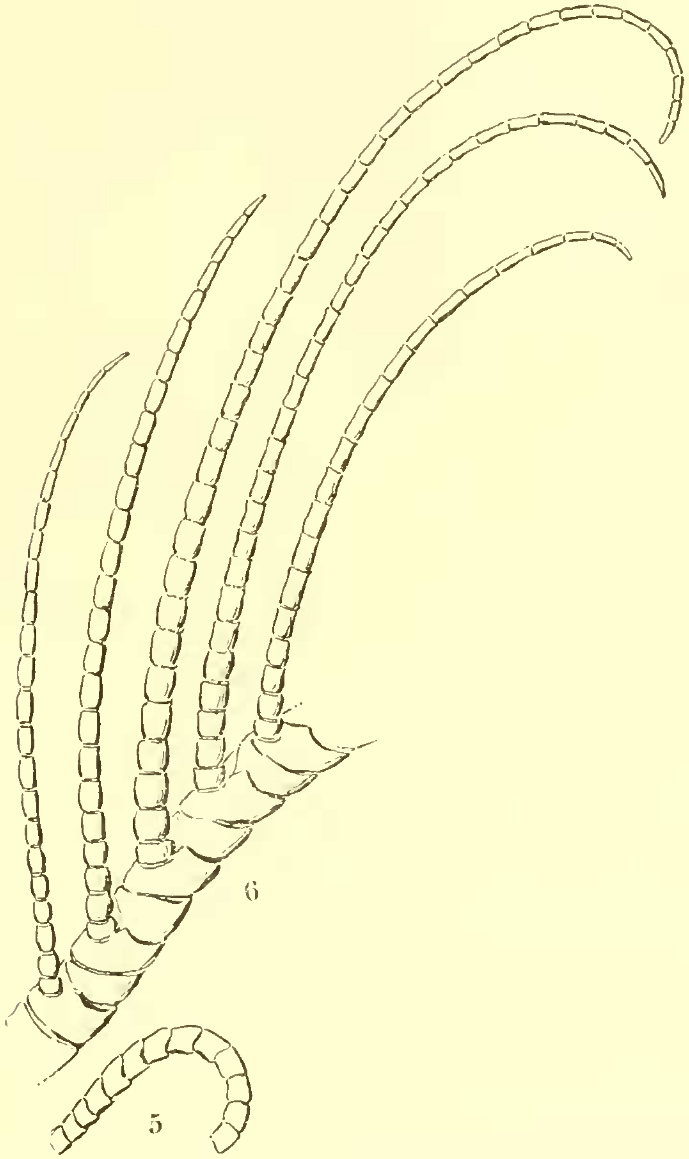
[1] *νόμιμος* = *conventional*, in reference to the fact that this species shows best the typical characters of he genus.

P_1 (fig. 6) is about 12 mm. long, very slender, with about 23 segments, of which the basal six to twelve are about as wide as long but beyond that the length increases and the moniliform character of the pinnule disappears near the tip. P_2 is about 14 mm. long and has some 25 segments but only 2 or 3 at the base are as wide as long, and distally they are twice as long as wide. P_3 is much longer and stouter, apparently about 25 mm. long (the terminal portion is too much curved and twisted for measurement) with more than 30 segments. P_4 is



Figs. 5 and 6. Monilimetra nomima: 5, a cirrus (lacking terminal claw); 6, pinnules p_1—p_5. x 8.

about equally stout but is not so long, although it has about 30 segments. P_5 is much smaller and shorter with about 20 segments. The following pinnules are somewhat smaller but soon increase in length though they remain very slender. Beginning with the third pinnule, the outer distal corner of each segment projects as a minute spine and the distal margin begins to be slightly serrate; this spininess of the distal margin of the pinnule segments becomes very marked near the middle of the arm but decreases again on the distal pinnules.

Color (dry): brown, lightest on centrodorsal and arm-bases and again distally, darkest on dorsal side of brachials 8–20, where it is a deep purple-brown; the change of shade is very gradual, and nowhere abrupt. Beginning at the very base of each ray, a light yellowish-brown line, ill-defined and soon broken into irregular patches, runs out on the dorsal side of each arm; there are also minute specks of this light shade on each side of this line. Pinnules and cirri, light brown or even pale brownish-white. Arms distally, somewhat banded as each segment is brown with a broad light margin.

Holotype, M. C. Z. No. 953, dredged at Broome, W. A., June, 1932.

There are 4 paratypes and 2 other specimens which I am referring to this species. None of them is like the holotype in color. One is uniformly cream color dorsally and is probably bleached. Another appears to be uniformly yellow-brown, but under a lens, faint markings corresponding to those on the holotype are barely distinguishable. The other two paratypes are light reddish-brown or fawn-color, variegated with a darker purplish-brown; they are, however, in poor condition and were apparently stained, probably by contact with other echinoderms in the collecting or preparing of the specimens. A fifth specimen, somewhat similar to these but much lighter in color and a little smaller and more delicate in structure, is referred to this species but is not considered a paratype. There are XXXIII cirri with 13–15 segments, but they seem more slender and much less compressed than in the paratypes, none of which, however, have retained enough of their evidently very fugacious cirri for adequate comparison. As regards the pinnules, the proportions are just as in the types but the measurements and actual number of segments are considerably less than in the holotype. Thus P_3 has fewer than 20 segments and is only 10–15 mm. long, and P_4 is distinctly smaller but is much more like P_3 than like P_5. I take these peculiarities of the pinnules to be youthful characters, which would have soon been outgrown. Another specimen referred to *nomima* is very young with arms only 10–12 mm. long. The pinnules are all very slender and with few segments and the cirri are about XXV, 11. The chief reason for referring this very juvenile specimen to *nomima* is its resemblance to the much larger atypical fifth specimen just discussed, the peculiarities of which I believe are due to immaturity even though the arms are fully 30 mm. long.

Compared with the Comasteridae and Zygometridae, the Antedonidae are rare in the Broome region and were met with only now and then, not more than half a dozen times during each visit. The present species is undoubtedly the commonest and was taken at least four times. Two specimens were taken in Roebuck Bay in August, 1929, and early in September two more were dredged near False Cape Bossut. In 1932, three specimens were secured at different times in dredging between Broome and Cape Villaret.

Monilimetra lepta[1] sp. nov.

Centrodorsal low hemispherical, about 2 mm. in diameter, the bare pole rough with minute cirrus sockets; cirri XXXV, 15–17, crowded and more or less strongly recurved (fig. 7). Segments 4–6 are longest and least compressed but the length is scarcely equal to twice the diameter at middle; distally the segments become shorter and wider and moderately compressed; opposing claw low and inconspicuous; terminal claw small but sharp and curved.

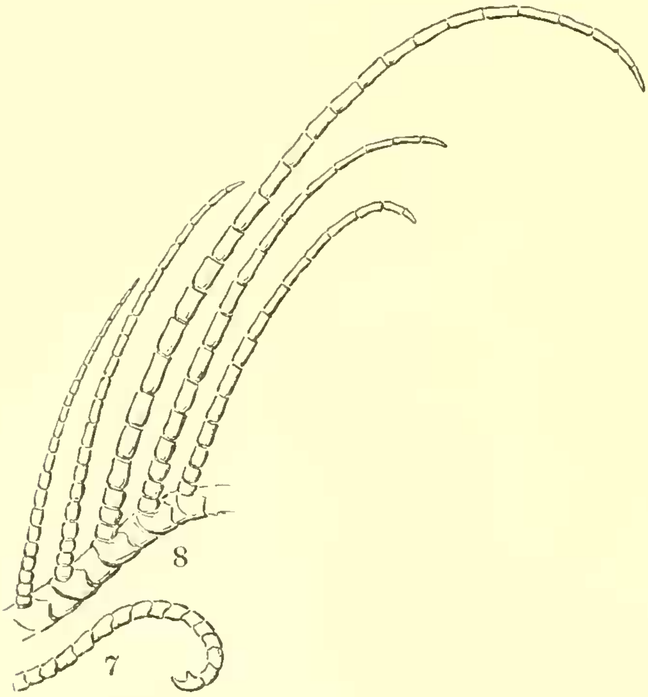
Radials concealed; I Br low, its width at least 4 times its length; axillaries more or less triangular or low pentagonal; the lateral margins may be considered as blunt points on a triangle, or as very short sides of a pentagon; the width of the axillary is considerably greater than its length. Synarthrial joints not very close and synarthrial tubercles insignificant or wanting. There are 10 approximately equal arms, about 35–40 mm. long; the number of brachials probably exceeds 80; the character of the brachials and position of the syzygies is essentially as in the preceding species.

P_1 (fig. 8) is about 6 mm. long, with some 20 segments, of which only the basal 6 or 7 are wider than long, so the moniliform character of the pinnule is not conspicuous. P_2 is similar but is longer and stouter with about the same number of segments but only about three basal ones are wider than long. P_3 is conspicuously longer, at least 15 mm., and stouter, with 23 or more segments, all but the two or three basal ones much longer than wide. P_4 is distinctly smaller with about 15 segments and P_5 is similar but smaller still. Subsequent pinnules not

[1] λεπτός = *delicate*, in reference to the slender arms and generally fragile structure.

peculiar. Spininess of distal margins of pinnule segments more or less evident under a lens but not at all conspicuous.

Color (dry): cirri, pinnules and sides of arms very pale brown, nearly white; dorsal surface of each arm with a broad dark brown or blackish stripe; in alcohol the color is not essentially different. Disk plump and relatively large, pale grayish, more brown on the anal papilla and dark along the margins of the food grooves.



Figs. 7 and 8. Monilimetra lepta: 7, a cirrus; 8, pinnules, p_1—p_5. x 8.

Holotype, M. C. Z. No. 950, from Broome, W. A., dredged in 5–8 fms. June, 1932.

There are five paratypes, also dredged in the vicinity of Broome in June, 1932. Apparently all of the specimens were taken at the same time and place. They agree well in structural details and are distinctly more slender than the preceding species, *nomima*. In color they show some diversity and not one has the dark stripe on the arms. Three are uniformly very light, a dull pale cream color on the dorsal side; one of these has the cirri white with no markings, while in the second a few distal segments of the largest cirri have a dusky blotch; the third has the cirri dusky or purplish-gray. The two other specimens have more or less dusky or light brownish-purple blotches on the brachials, on each side, but these are not conspicuous; in the larger, the cirri are nearly white, but in the smaller they are almost lead-color.

A seventh specimen, which may properly be called a paratype, was taken on Pearl Shoal in 1929; the arms are all broken and the cirri are nearly all gone but I do not hesitate to refer it to the present species as the pinnules correspond completely and such cirri as are present agree with those of *lepta*. The color, a uniform light shade not quite white, is also appropriate.

This species is the most Dorometra-like of any of the four Monilimetras at Broome. The moniliform character of the first pinnule is by no means striking and the resemblance of the comatulid to Dorometra is obvious.

MONILIMETRA POECILA[1] sp. nov.

Centrodorsal low hemispherical, more than 2 mm. in diameter, the small bare area at the pole without evident cirrus sockets; cirri XXXIII, 16–18, crowded and more or less recurved (fig. 9); segments short and wide, the first three are wider than long, the fourth is about as wide as long, the fifth and sixth are evidently longer than wide; the following segments are about as long as the distal width; opposing claw low and insignificant; terminal claw small but sharp and curved; while the cirri are flattened on the sides they are not markedly compressed.

Radials concealed; I Br low, its width about 4 times its length; axillaries low pentagonal, lateral margins very short, width greater than length. Synarthrial joints not at all close, the lower brachials in particular being very noticeably separated, except at the very margin. Arms 10, rather unequal, longest exceeding 50 mm.; several are regenerating distally; the number of brachials exceeds 140 on the longest arm. The form of the brachials and the position of the syzygies is essentially as in *nomima*.

P_1 (fig. 10) is about 8 mm. long, with some 20 segments, of which the basal are as wide as long and even distally the length exceeds the width very little, yet owing to the lack of constrictions between the segments the moniliform character of the pinnule is not so striking as might be. P_2 is similar but is longer and stouter; the number and relative proportions of segments is about the same. P_3 is conspicuously larger in every way, nearly 20 mm. long with about 24 segments. P_4 is very similar to P_3 and little if any smaller. P_5 and subsequent pinnules decrease uniformly in size to about P_{11} or P_{12} after which the length increases a little but

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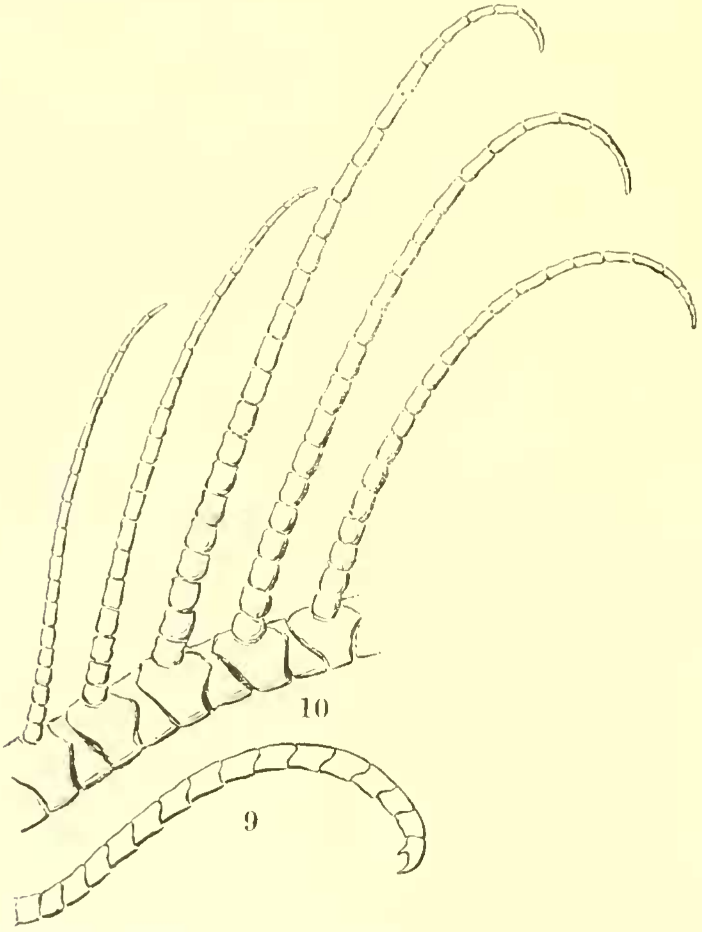
[1] ποικίλος = *variegated*, in reference to the strikingly handsome coloration.

the stoutness does not. Spininess of distal margins of pinnule segments more or less evident on P_4–P_{10} but is not very conspicuous.

Color (dry): variegated, whitish, yellow and purple; ground color of centrodorsal, cirri, base of arms and pinnules, whitish, of dorsal side of arms, yellow; on each cirrus segment (excepting the most proximal and the two terminal) is a conspicuous purple spot, and often these spots tend to run together dorsally, making an incomplete (sometimes complete) girdle around the segment; each pinnule has 8-10 purple bands of somewhat indefinite position and completeness; each basal brachial has a large purple spot on each side dorsally but beyond the eighth, the spots tend to coalesce more or less into an indefinite band of dull purple or dusky; the regenerating portions of the arms are a uniform light yellow



Figs. 9 and 10. Monilimetra poecila: 9, a cirrus; 10, pinnules p_1—p_5. x 8.

without markings but the pinnules borne thereon are banded; disk variegated whitish and purple.

Holotype, M. C. Z. No. 956, dredged in 5–8 fms. between Cape Vilaret and Broome, W. A. June, 1932.

There are three paratypes but all are more badly broken than is the holotype. One of these, taken at the same time and place, is similar in size and structure so far as can be determined, but is much darker in color, the yellow on the arms is pale, the purple is much more abundant and the spots have coalesced into broad irregular bands. The other two paratypes show the same contrast in color but it is even more marked; the lighter one is nearly white (possibly the yellow has been bleached in the alcohol in which it is preserved), variegated with a dull reddish-purple (the shade may have been altered in alcohol) and with the pinnules less frequently and conspicuously banded; the darker specimen is deep red-purple with a whitish mid-dorsal line on the I Br series and the pinnules purple and white banded as usual.

This unusually lovely comatulid is very sensitive to handling and only the holotype has any arms still attached to the calyx. Two of the paratypes were taken September 5, 1929, "at extreme low water, far south of the jetty" at Broome. My field notes go on to say, "ten long, slender, very graceful arms; finely variegated with purple and white; very delicate and went all to pieces in pail, breaking the arms up into little bits." When the two specimens taken in 1932 were dredged the present holotype was very little damaged, so it was possible by plunging it at once into strong alcohol to get a very good specimen, even the cirri remaining in place. Obviously this fine species cannot be considered at all common in the Broome region.

MONILIMETRA BICOLOR[1] sp. nov.

Centrodorsal low, hemispherical, about 2 mm. in diameter, almost completely covered with cirri, which are about XXXVIII, 15–17, crowded and more or less recurved (fig. 11); segments 4–6 elongated, more than twice as long as the diameter of the nearly cylindrical middle; succeeding segments longer than wide and increasingly compressed; opposing claw sharp and rather prominent; terminal claw sharp but not strongly curved.

Radials concealed; I Br low, its width at least 4 times its length; axillaries low pentagonal with the lateral margins very short and the width much greater than the length. Synarthrial joints very open at least as far as the ninth or tenth brachial. Arms 10, approximately equal, about 35–40 mm. long; the number of brachials exceeds 80; the character of the brachials and position of the syzygies is essentially as in *nomima*.

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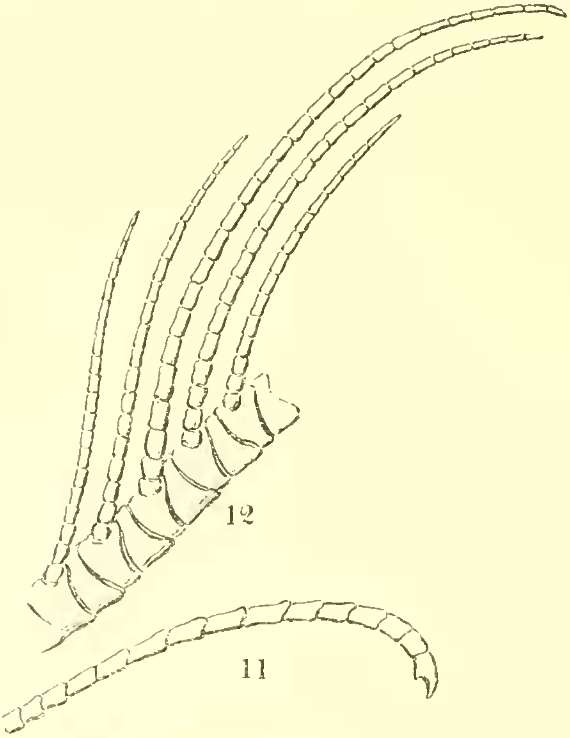
[1] *bicolor* = of two colors, in reference to the characteristic coloration.



Figs. 11 and 12. Monilimetra bicolor: 11, a cirrus; 12, pinnules p_1—p_5. x 8.

P_1 is 5 or 6 mm. long with some 20 segments, the basal ones short and wide, the distal somewhat longer than wide; on the whole the pinnule is quite moniliform. P_2 is longer and less moniliform but has about the same number of segments. P_3 is much longer and stouter, 12–15 mm. long with about 25 segments, all but the basal 2 or 3 much longer than wide. P_4 is almost as long and stout as P_3, while P_5 is markedly smaller and P_{10} is the smallest of the pinnules. Spininess of distal margins of pinnule segments, not very marked but with a lens it is evident on the basal and middle joints of pinnules 3–10.

Color (dry): calyx and basal part of arms, deep-purple; pinnules (except some of the larger basal ones) lighter and distally quite light, so the arms appear distinctly lighter near tips; cirri pure white in striking contrast, the very basal segments, however, are deep purple.

Holotype, M. C. Z. No. 946 from 5–8 fms., between Cape Villaret and Broome, W. A., June, 1932.

There are three paratypes as follows:

Near False Cape Bossut, September, 1929. 1 specimen like the holotype, but all cirri and most pinnules are wanting.

Near entrance to Roebuck Bay, June, 1932. 1 specimen somewhat larger and darker than the type (pinnules are dark); all cirri wanting; arms about 50 mm. long.

Pearl Shoal, 7 fms. September 26, 1929. 1 superb specimen. Arms about 60 mm. long, cream-white, but pinnules on basal 10–18 mm. of each arm, red-purple in sharp contrast; cirri pure white.

This species is very close to *nomima* and might perhaps be considered a color form of that species but the difference in the cirri seems to be constant and the coloration of the present form is so striking it seems better to regard it as a distinct species. It is evident that it cannot be considered common in the Broome region.

ASTEROIDEA

The collection of sea-stars contains 4270 specimens, representing 46 genera and 104 species. Of the genera 3 are new, one being simply a subdivision of the old genus Anthenea, while each of the other two is based on a single specimen of a sea-star so very unusual as to necessitate a new generic group. Of the 104 species, no fewer than 29 represent hitherto undescribed species, of which a dozen belong to the family Asterinidæ and half a dozen others represent the old genus Anthenea, in a broad sense.

The new genera are:

STYPHLASTER, type *S. notabilis* sp. nov. Monotypic.

GYMNANTHENEA, type *Anthenea globigera* Död. There is a second species at the Abrolhos Islands, W. A.

MANASTERINA, type *M. longispina* sp. nov. Monotypic.

The 29 new species are scattered through 16 genera, as follows:

Astropecten pulcherrimus	W. A., Broome.
Luidia hexactis	W. A., Montgomery Reef, Collier Bay.
Archaster laevis	W. A., Broome.
Goniodiscaster acanthodes	W. A., Broome.
Goniodiscaster bicolor	W. A., Broome.

Styphlaster notabilis	W. A., Broome.
Anthenoides dubius	W. A., Broome.
Gymnanthenea laevis	W. A., Abrolhos Islands.
Anthenea acanthodes	Q., Port Curtis.
Anthenea crassa	Q., Port Curtis.
Anthenea elegans	W. A., Broome.
Anthenea obesa	W. A., Geraldton.
Anthenea polygnatha	W. A., Broome.
Bunaster variegatus	W. A., Bunkers Bay.
Asterina alba	Lord Howe Island.
Asterina heteractis	Lord Howe Island.
Asterina lutea	W. A., Broome.
Asterina perplexa	Lord Howe Island.
Disasterina spinulifera	W. A., Broome.
Manasterina longispina	W. A., Rottnest Island.
Paranepanthia rosea	W. A., Rottnest Island.
Patiriella brevispina	W. A., Bunbury.
Patiriella nigra	Lord Howe Island.
Nepanthia magnispina	W. A., Augustus Island.
Nepanthia tenuis	W. A., Broome.
Nepanthia variabilis	W. A., Broome.
Parasterina occidentalis	W. A., Point Peron.
Echinaster varicolor	W. A., Broome.
Astrostole insularis	Lord Howe Island.

As shown by the above list Lord Howe Island is the home of 5 of the new species, and Port Curtis, Queensland of 2; all the remaining 22 are Western Australian. Captain Bardwell secured 2 of these at or near Augustus Island, while the vicinity of Broome is the home of 13. The coast from Geraldton southward to Bunkers Bay, with its outlying islands (Abrolhos, Rottnest) provides the type localities for 7 species.

Sea-stars are the most generally observed and collected of Australian echinoderms. The more or less striking form and the frequently brilliant colors make even a pearl-shell diver stop and look, while fishermen of all sorts are apt to bring them in, now and again, as a part of their spoil. The clear waters and firm sandy bottoms in the vicinity of Broome make that part of the Australian coast the richest collecting ground for a student of sea-stars, no less than one-third (35) of the present list having been taken in that region. The Barrier Reef area also has a notable sea-star fauna but is not so well represented in the present list since we did not do any collecting there. On the southern coast of the continent the asteroid fauna is less abundant but is notable for many characteristic genera and species, of which only a few appear in the present work. Western Australia between Geraldton and Albany has a very considerable number of sea-stars, many of which are characteristic of that coast. In all regions, the smaller species live beneath rock fragments or in crannies and holes in the rocks while the larger ones commonly lie more or less exposed on the bottom. A few species frequent wharf piles or lie buried just below the surface on a sandy bottom, but none will be found where the water is brackish or befouled with mud.

The literature dealing with Australian sea-stars is fairly extensive. Sladen's monumental work on the "Challenger" Asteroidea (1889) is of course invaluable. Bell's report on the "Alert" collection (1884) suffers from that writer's well-known idiosyncrasies. My reports on the "Thetis" Echinoderms (1909), the echinoderms of the Western Australian Museum (1914), the "Endeavour" echinoderms (1916), the Echinoderms of Torres Strait (1921), "Some Echinoderms from West Australia" (1923), and the echinoderms of the South Australian Museum (1928) all contain more or less material concerning sea-stars. Fisher's admirable and always trustworthy monographs (1906, 1911, 1919, 1928, 1930) and Döderlein's[1] very helpful accounts of Semon's Torres Strait sea-stars (1896) and of the "Siboga" asteroids (1917, 1920, 1935) are indispensable. Döderlein's small monographs on Anthenea (1915) and Oreaster (1916) are also valuable. In very recent years, Livingstone has published a number of excellent papers (1930–1936) which warrant the belief that Australian sea-stars now have a master, whose work will be worthy of the rich and fascinating field into which he has entered. In the study of the present collection, I have had the very great advantage of constant correspondence with both Fisher and Livingstone. The latter has seen nearly all of the collections and the former has examined many of the more interesting or perplexing specimens. The unfailing interest and helpful suggestions of these colleagues have been of incalculable value and have no doubt saved me from errors. If any serious blunders are detected in the present account of Australian sea-stars, it will be the fault of the writer only and in spite of my colleagues' cheerful readiness to help. Through Mr. Livingstone, the Australian Museum, has generously loaned me material of the greatest importance for my attempts to elucidate the perplexing genera Anthenea and Nepanthia.

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[1] The recent death of Dr. Döderlein is a great blow to all students of echinoderms, for the care with which his work was done and his sound judgment made his work invaluable to his colleagues even when we could not accept his conclusions.

In collecting sea-stars, little care need be used in the handling, save in the case of Luidia. In this genus, there is a tendency, when roughly or even carelessly handled, to constrict muscles at the base of each arm which autotomously sever the arm from the disk; once this process begins it is almost impossible to check it. But if the specimen can be placed in a basin of fresh sea-water before the impulse starts, narcotization with Epsom salts ($MgSO_4$) is usually easy, after which killing can be done without danger of injury. All sea-stars, so far as my experience goes, are very susceptible to Epsom salts, after the use of which, they may be placed in alcohol or formalin for killing. They may be left in alcohol indefinitely but never in formalin more than a few hours, at the most. If they are to be dried, the formalin (about 4% of the commercial fluid) should contain some corrosive sublimate ($HgCl_2$) — not too much or a whitish film may form on the specimen; something less than 1% $HgCl_2$ is ample.[1] Better specimens of many sea-stars, particularly those with arms of considerable bulk, may be prepared if instead of being narcotized they are killed by being transferred directly from sea-water to fresh-water; they may later be placed in the corrosive-formalin until completely saturated therewith and then dried as rapidly as possible in the shade or in an oven, not too hot. The colors of sea-stars are lamentably evanescent and it is impossible to retain them in Museum material, except when they are dull and of little interest. Alcoholic specimens always bleach more or less but specimens killed quickly in corrosive-formalin and then dried rapidly and thoroughly, may retain a considerable amount of pigment and will hold for years more or less resemblance to the living animal.

ASTROPECTINIDAE

ASTROPECTEN GRANULATUS

Plate 1, fig. 1

MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 75.

This is the common sea-star at Broome, occurring in considerable numbers on the sandy-mud bottom of Roebuck Bay, near normal low water mark and further out. Most of the specimens seen were of moderate size, with R = 50–75 mm. but many larger ones were taken with R = 100–118 mm.; the smallest at hand, with 10 superomarginals in each series, has R = 7 mm., r = 3 mm., and br = 3.5 mm. while in the largest with 45 superomarginals, R = 118 mm., r = 22 mm., and br = 25 mm. The change of form from youth to age is therefore very great, the ratio of R to r and br undergoing a marked alteration; in youth R = 2.3r and 2 br while in the full grown adult R = 5.4r and 4.75br[1]. But the adult ratios are approximately reached while *granulatus* is still less than half grown; specimens with R = 50 mm. have very nearly the proportions of adults. It is of interest to note that while the arm increases in length from 7 to 50 mm., i.e., 7x, the number of superomarginals has increased only from 10 to 30, i.e., 3x; when the arm reaches 118 mm., i.e., 17x the youthful length, there are only 45 superomarginals; the arm-length has thus increased about four times as fast as the number of superomarginals.

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[1] Dr. R. T. Jackson has prepared beautiful dried specimens, using simply a very dilute solution of corrosive sublimate. His account of his method should be consulted (1930).

In life, the dorsal surface of this sea-star is a deep bluish-gray, very similar to the color of the sandy mud in which it lives; this color disappears completely in preserved specimens. The lower surface and marginal spines are pure white; the pedicels are cream-colored. In young individuals when R = 12–15 mm., the tips of the arms are dusky; as the arms increase in length this dusky area forms a band across the tip; when R = 20 mm., a second dusky area may appear and form another band across the arm. These bands are brown in color when fully formed and brown areas now appear, in many individuals, on the disk in the interradii. As the specimens increase in size, these bands and areas break up into irregular blotches and spots occupying the same general positions near the middle of the arm and in the interradii. They reach their maximum development when R = 50–60 mm.; after that they begin to disappear and in specimens with R = 100 mm., they are poorly defined or lacking. Specimens dredged on a bottom of ordinary sand in 5–7 fms. were more yellowish-gray or brownish than those found at and near low watermark around the jetty at Broome. In the intertidal zone, this Astropecten was easily detected when the tide was out by the star-shaped figure in the sand, caused presumably by the water currents among the paxillæ of the dorsal surface; hence the size as well as the form of the sea-star was indicated though the animal itself was wholly buried.

Some years ago, I recorded *Astropecten granulatus* from South Africa (1923, Ann. So. Afr. Mus., **13**, p. 250), the identification being based on a dozen specimens with R = 7.5–38 mm., and I even affirmed that Sladen's species *monacanthus* was the same thing. Now that a large amount of material is available, it is perfectly clear that *monacanthus* is a distinct species and the two can be easily distinguished. Comparison of the South African specimens with the material from Broome indicates that it is quite different and further study suggests that it is nearer to *A. notograptus* Sladen than to any species hitherto described. Hence *granulatus* should be deleted from the list of South African sea-stars.

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[1] It must be constantly borne in mind that the form and proportions of sea-stars are often modified to a notable degree by the method of preservation; dry specimens are greatly affected by the rapidity or slowness of drying. This is particularly true in Astropecten.

The 53 specimens of *granulatus* at hand were all taken in or near Roebuck Bay, mostly in the vicinity of the jetty at Broome.

ASTROPECTEN HARTMEYERI

DÖDERLEIN, 1917. "Siboga" Ast.: Astropecten, p. 156.

The material upon which this species is based was collected at Shark Bay, Western Australia. It is not surprising therefore that it proves to be a common sea-star in the vicinity of Broome, but it is interesting to note that the range extends still further to the northeast as far as Augustus Island, where Captain Bardwell collected 3 fine specimens.

The largest of those taken at Broome has R = 82 mm. and is therefore nearly twice as large as the type material, but a still larger specimen is at hand, in which R = 110 mm., r = 18 mm. and br = 20 mm. The arms are thus relatively more slender than in Döderlein's material but this is what would be expected, as shown by the measurements given for *A. granulatus* (See p. 61). This very large, dried specimen belongs to the Western Australian Museum and is from the coast of that State but the exact locality if not known. The color is very dark, an apparently uniform brown without any markings, quite different from the handsomely marked smaller specimens, but, except that the spinulation is much coarser than in the Broome material, the resemblance of this big individual to the smaller ones is surprisingly close. The largest Broome specimen is the darkest of that series but is as clearly marked as the smaller ones; the smallest (R = 10–14 mm.) are very light, except for the darker markings. A single specimen, taken between Broome and Wallal, with R = 36 mm., is very dark and the markings are difficult to make out; such an individual might easily grow into a dark, unicolored adult.

The specimens from Augustus Island are noticeably different from those taken at Broome in the much wider rays; R = 60 mm., while r and br are each about 15 mm. A Broome specimen with R = 65 mm. has r and br only 12–13 mm.

and this is the usual ratio in the adult Broome material, but some of the smaller specimens have R only =4 r. The color of the Augustus Islands specimens also sets them apart, for while the dark markings are evident, the ground color is dull and there is a dingy pink tinge evident, particularly on the lower surface. This may however be artificial due to some chance element in their preservation, for they are admirably dried.

Whether *hartmeyeri* is really distinct from *zebra* Sladen seems to me rather doubtful but the only specimens of *zebra* available for comparison are too young to be of real service. Larger collections from Northeastern Australia are necessary for a final decision.

The 31 specimens of *hartmeyeri* at hand come from the following places, all on the coast of Western Australia.

Augustus and Champagay Islands, October, 1933. Capt. Beresford E. Bardwell leg. 3 specimens.

Broome, 5–8 fms., September, 1929. 2 specimens, adult.

Broome, Pearl Shoal, 5–8 fms., September, 1929. 4 specimens, young.

Broome and vicinity, 5–8 fms., June, 1932. 20 specimens, adult and young.

Between Broome and Wallal, 1930. R. A. Bourne leg. 1 small adult. Loaned by the Australian Museum.

Locality unknown. 1 very large adult. Loaned by the Western Australian Museum.

ASTROPECTEN MONACANTHUS

SLADEN, 1883. Jour. Linn. Soc. London: Zool., **17**, p. 263.

Sladen's types were only half-grown but Döderlein (1917, p. 150) has given a good account of this sea-star with excellent figures. It is a widespread species of the Indian Ocean, and has been taken previously on the northwestern coast of Australia. It is not very common in the vicinity of Broome and was not taken above the lowest tide mark or near the jetty, but there are 13 specimens at hand, of which 4 young ones were dredged in September, 1929, near, if not in, Roebuck Bay, one half-grown individual (a loan from the Australian Museum) was taken by Mr. R. A. Bourne, in 1930 between Broome and Wallal, and 8 were dredged in June 1932 in 5–8 fms., southwest of Broome; the last lot range from very young ones with R = 7 mm. to an adult with R = 48 mm., the largest specimen yet recorded. In this specimen r = 11 mm. and br = 12.5 mm., so that R is a little more than 4r and a trifle less than 4br. A rather marked change in form occurs after

$R = 16–18$ mm. Prior to that the arms are pointed, their width at base is more than one-third R and the sides are straight; thereafter the arms become blunt, the width at base is proportionately less but near tip is more, and the sides curve inward distally.

The color in life (grayish, more or less evidently blotched with dusky or brown, particularly near the middle of the arms or distal thereto) is so much like that of *granulatus* that the two species were confused during collecting and only after they were dried and examined with a lens were the very obvious differences between the two species noticed. The opinion I expressed some years ago (1923, Ann. S. Afr. Mus., **13**, p. 250) that the two species are identical is quite wrong. The difference in the spinulation of the inferomarginals is not emphasized by Sladen but Döderlein's figures (1917, pl. XVII) bring it out fairly well. The flat, rounded scale-like spines which cover the inferomarginals in *monacanthus* are recognizable even in specimens in which R = only 7 mm. and are distinctive in specimens with R = 13 mm. The conspicuously flattened and widened outer adambulacral spines of *monacanthus* are also distinctive after R = 12 mm., and in large specimens (R = 40–50 mm.) the difference in the shape of the arms is obvious.

ASTROPECTEN POLYACANTHUS

MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 69.

We met with this species only at Port Jackson, from which place it has long been known. There 2 specimens, with R = about 60 mm., were dredged near Middle Head, November 21, 1929. In life the coloration was striking; the paxillar area of the dorsal surface was deep purple, while the oral surface was more or less red-orange, with the margins pale yellow; the marginal plates were more or less purplish dorsally but faded out into yellow orally. These fine colors have entirely disappeared in the dry specimens.

Mr. Melbourne Ward has generously sent me 2 unusually large and striking specimens labelled: "Beaches. Lindeman Island. Aug. 1934." This locality is on the Barrier Reef not far from Port Mackay, Queensland. One of the specimens has R = 105 mm. (or more) and r only 21; it is thus a little larger than Müller and Troschel's type-specimen (see Döderlein, 1917, p. 135) and the rays are a little narrower. The color is a rather bright brown with the unusually long marginal spines whitish; many of the inferomarginal spines are 10 to 11 mm. long and little more than a millimeter wide, quite flat but sharply pointed. The other specimen is a little smaller and the color is a gray-brown with the spines white. The marginal spines are as conspicuous as in the larger specimen and even more bristling; several are 12 mm. in length; they are as a rule somewhat less flattened than in the other individual. On the whole these specimens resemble more closely one in the M. C. Z. collection from Zanzibar, with R = 85 mm., than they do the Port Jackson specimens, with their shorter, wider rays.

Astropecten preissii

Müller and Troschel, 1843. Arch. f. Naturg. **9**, 1, p. 119.

Southwestern Australia is the type locality for this fine species but the range extends eastward along the southern coast at least as far as St. Vincent Gulf. Michaelsen and Hartmeyer found it near Fremantle and also near Albany, W. A. Döderlein (1917, p. 162) suggests that the latter specimens represent a local form which he calls *albanicus,* but some of our specimens from Fremantle correspond very closely with the description given, though they are less like the figure. Only further collecting in southwestern Australia can determine whether the wide-armed form is a constant variety but I am inclined to doubt it.

Between Fremantle and Garden Island this sea-star is quite common and we secured a good series ranging from R = 6 mm. to R = 155 mm. In the very small specimens the rays are of course notably short and R = only 2r; when R = 32 mm., the proportion is R = 4r; at 70 mm. R = 5r; at 126 mm., r = 6r; and at 155 mm., R = 7r. In the last mentioned specimen, there are 78 superomarginals, and a number of them scattered here and there bear small erect spines as in Döderlein's largest specimen.

In life, there are two color forms but as the colors fade completely after drying and all assume the usual "museum-color," no other difference can be detected. The possibility of this being a secondary sex character deserves investigation. Most commonly the color is yellowish-brown or brownish-orange, with the distal ends of the inferomarginal plates orange. In striking contrast, the other form is rich violet. Both are unicolor without markings.

The material in hand consists of 40 specimens from the following localities:

Western Australia: Shark Bay, 2 fms., December, 1923. 1 adult. Loaned by the Western Australian Museum.
Between Fremantle and Garden Island, 2–3 fms., October, 1929. 30 specimens, young and adult.
Locality doubtful. 9 specimens, young.

ASTROPECTEN SCHAYERI

DÖDERLEIN, 1917. "Siboga" Ast.: Astropecten, p. 60.

It is a matter of great interest to find in the Victoria National Museum at Melbourne, a specimen of this remarkable Astropecten. It is of almost exactly the same size and appearance as the type but is in somewhat better condition. The group of actinolateral plates in each interradial area is very striking as are the very numerous adambulacral and oral spines. Döderlein's opinion that this is the most primitive of known Astropectens seems to me quite justifiable.

The unique holotype was taken in "Tasmania" and is now in the Berlin Museum. The Melbourne Museum specimen bears the label "Portland, Victoria. Presented by Goldstein, 19.4.79." The resemblance of this species to *A. pectinatus* Sladen from the southeastern coasts of Australia is striking, and one is at first inclined to think them identical, but in addition to the important difference in the actinolateral plates, which Döderlein stresses, the difference in the large spines of the inferomarginal plates is very great, the adambulacral armature is different and the madreporite is more nearly marginal in *schayeri*.

ASTROPECTEN TRISERIATUS

MÜLLER and TROSCHEL, 1843. Arch. f. Naturg. 9, 1, p. 118.

On October 14, 1929, while dredging between Fremantle and Garden Island, we took an arm fragment of an Astropecten which was conspicuously different from *preissii*, the common Astropecten of that area. The superomarginal plates bore many spines in striking contrast to the unarmed superomarginals of *preissii*. The dorsal surface of the fragment was grayish, the sides and lower surface cream-color or yellowish. The fragment is about 50 mm. long, 20 mm. wide at one end, 15 mm. at the other. Comparison with a specimen of *triseriatus* loaned by the Western Australian Museum, in which R = 80 mm., shows that the fragment is part of the middle of the arm of a *triseriatus* in which R = about 110 mm. The type locality for the species is Southwestern Australia but it seems to be rare and few specimens are known. Döderlein (1917, p. 126) records one, with R = 97 mm., from Northwestern Australia which he compares with the type, a much smaller individual. The specimen loaned by the museum at Perth is in good condition, though one ray is regenerating. R = 80 mm., r = 16, R = 5r. Nearly all the superomarginal plates have 3 erect spines and some have 4. This individual was found at South Beach, Fremantle, in November, 1932.

ASTROPECTEN VAPPA

MÜLLER and TROSCHEL, 1843. Arch. f. Naturg., **9**, 1, p. 119.

The type of this species is a very small specimen in the Berlin Museum with R = 23 mm. Of the 7 specimens at hand, 4 are of approximately the same size, but 3 are much larger. One has R = 40 mm. and is a fairly typical example of the species. Together with a smaller specimen it bears a label with a note on the color in life but there is no locality given. The note on color is written on the back of an Australian Museum label and reads: "Pale gray dorsally, more or less cream orally and marginally, with interradial superomarginal spines tipped with bright brown-orange." There is little doubt that these specimens were dredged near Middle Head, Port Jackson, November 21, 1929. The species has long been known from the New South Wales coast though unfortunately misidentified by both Whitelegge (who called it *triseriatus*) and myself (who called it *pectinatus*), as Döderlein long ago pointed out (1917, p. 125). My accounts of *pectinatus* in the "Thetis" Report (1909) and in the "Endeavour" Report (1916) undoubtedly refer to *vappa*; the only excuse that can be offered is that *vappa* was quite inadequately known prior to 1917, when Döderlein's masterly revision of the genus Astropecten was published, bringing order out of chaos and making all students of sea-stars his lasting debtors.

Besides the two specimens from Port Jackson there are three young individuals from the southwestern coast of Australia, given to me by Professor E. W. Bennett. One is very well preserved but lacks a locality label. The others are obviously from beach wrack and are labelled: "Drift on Middleton Beach, February, 1929. E. W. Bennett." Middleton Beach is near Albany, W. A. The type locality for *vappa* is Southwestern Australia and it has been recorded from Shark Bay, W. A. by Döderlein (1917).

Mr. Melbourne Ward has kindly sent two specimens of *vappa* bearing the label: "Sand flats. Lindeman Island, Cumberland Group, Queensland. July–October, 1934." This is much the most northern point at which *vappa* has been taken. These individuals are about half grown, with R = 60–68 mm. The color seems to have undergone little change; the upper surface is variegated light and dark gray; the lower is cream-white. The superomarginal spines are relatively few and very small, but the inferomarginals are very long (often 6–7 mm.) and conspicuous.

Astropecten velitaris

Von Martens, 1865. Arch. f. Naturg., **31**, 1, p. 360.

This East Indian sea-star is not uncommon in water 5–8 fms. deep, near Roebuck Bay and southwestward along the coast. Nearly all of the 17 specimens dredged in September, 1929 and in June, 1932 are adults and several are larger than any specimens yet recorded. The series ranges in size from R = 14 mm. (R = 4r) to R = 96 mm. (R = nearly 7r). The large specimens thus show a much greater length of ray proportionately than has previously been accredited to the species. Even the smallest individual with R only 14 mm. has the erect spines on the first superomarginal plates conspicuous while the occurrence of spines on the second superomarginal plate is common in specimens with R = 60 mm. or more. In no case however are more than 4 spines present in a single interbrachial arc. In the living animal the arms are relatively wide and flat, or about equal to one-fourth R, but the proportion alters when the specimens are killed (particularly if subsequently dried) and in some large specimens R = 6 br.

This is a handsome species when living as the following notes on the color in life indicate. "Youngest specimens greenish-gray, irregularly blotched with a dusky shade; just a tinge of purple on the superomarginal plates and a few superomarginal spines showing orange at base. Adults, oral surface and inferomarginal spines white, but there is more or less of an orange area on the basal half of each spine. Upper surface fawn-color with two (sometimes only one) irregular blotch-like cross-bands of a dark shade near middle of each arm or distal thereto. Superomarginal plates, terminal plate and an interradial line or blotch extending inward on disk from margin two-thirds of the way to center, purple or violet. Superomarginal spines, orange, tipped with purple. In the largest specimens, the colors are less bright."

Astropecten pulcherrimus[1] sp. nov.

Plate 1, fig. 2

R = 62 mm. (in life about 68); r = 16 mm. (in life, about 20); br = 17.5 mm. (in life, about 22). In life R is about 3.5r and rather more than 3br but in the dry holotype R nearly equals 4r and 3.5br. In a small paratype (also dry) with R = 46 mm., the arms are a little narrower and R = 4br. Rays taper gradually to a rather wide and rounded tip ending in a moderate terminal plate having a distinct median depression. Superomarginals 28, those in the interbrachial are more than 4 mm. high, not 2 mm. long (i.e. parallel to the longitudinal axis of arm) and approximately 2 mm. wide, but width merges in height too gradually to make an accurate statement possible; distally the plates become lower and occupy more of the upper surface of arm, the eighteenth for example being only about 2 mm. high and 2 mm. long but nearly 3.5 mm. wide; superomarginals and terminal plate covered with granules, of which those at the upper end of the interbrachial plates are largest (about .30 mm. in diameter) while those on the distal and terminal plates are scarcely half so large; there is no indication of superomarginal spines. Paxillae numerous and densely crowded; the larger ones in the interradial areas have about 16 marginal papillae, short and thick, and about 8 granules on the top; at base of arm there are 14–16 longitudinal series of paxillae, and the number does not decrease greatly towards the arm tip but the individual paxillae become smaller and smaller. No madreporite is visible.

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[1] *pulcherrimus* = most beautiful, as this is certainly the loveliest member of the genus. But alas, the beauty is ephemeral!

Interradial areas below with only 2 plates on each side of the midline; each of these carries 8–10 spinelets most of which are flattened and widened at tip. Inferomarginal plates about 28 in number, their size and position corresponding well with the superomarginals; they are covered closely with short, flat, scale-like spinelets, widened and truncate or rounded at tip; at the outer end of each plate is a single stout spine, which on the proximal plates is flat and truncate but becomes less flat and more pointed distally; at the base of the arm, these spines exceed 3 mm. in length and are about .75 mm. wide at tip; below this terminal spine but along the aboral margin of the plate (except on the first plate where it is nearly central) is a widely spaced series of 3 or 4 (rarely 5) much smaller but somewhat similar spines; beginning about the fifth or sixth plate one of the scalelike spinelets near the base of the uppermost of this series becomes enlarged and a little further out a second one also, so that there is a trio of flat spines at the outer aboral corner of the plate; distally the aboral spinelets disappear, the aboral margin near the middle of the arm having 2, then 1 and then none of them; at the tip of the arm there are simply 2 reduced but relatively large spines on the aboral outer corner of plate.

Adambulacral armature consisting of about ten or a dozen spines, 2 mm. long (more or less), flattened and widened at the tip to a greater or less degree; one is somewhat curved and set edgewise on the furrow margin; while a little back of it are 2 others, one on each side; back of them and more widely separated are 2 others with conspicuously widened tips; then follow, on the surface of the plate

2 or 3 more with very wide tips and behind them, several much smaller and less conspicuous spines. Oral plates covered with about 4 series of thick blunt spines, of which the innermost are longest and largest; the marginal spines are much more slender than those on the median crests.

Color in life extraordinarily brilliant for an Astropecten; the lower surface, marginal spines and most of the superomarginal plates are pure white; 6–9 superomarginals, in each series, bright rose-red in sharp contrast; these red plates are arranged in three (or only two) well separated groups on each side of each arm, the distalmost consisting of a single plate or sometimes two. Paxillar surface of arms bright brownish-orange, with irregular groups of blackish spots in the interradii and 3 or 4 smaller ones scattered along the arms. The dried specimen is a uniform light brown with marginal spines and most superomarginal plates still lighter; in each interradius is a definite group of spots of a distinctly purple shade.

Holotype, M. C. Z., no. 3123, from Lagrange Bay, northwestern Australia, in about 5 fms. June 10, 1932.

This extraordinary sea-star was brought up by our diver, Mr. Norman Whitworth, who reported that he found it lying on the bottom beside a sponge. Later, between Lagrange Bay and Broome we dredged a smaller specimen, with R = 46 mm., showing essentially the same coloration. A few days later a third specimen was secured in an extraordinary manner. A Japanese diver whom we knew as "Wan" brought up a fine large specimen of *Stellaster princeps,* a sea-star of sufficient rarity to make additional specimens very welcome. Turning it over to look at the handsome purple and white oral surface, we were amazed to find an Astropecten of this species half-enclosed in the Stellaster's stomach! It was carefully rescued from its living death but the disk and basal part of the arms were already partially digested and only the distal portion of three rays were uninjured. This individual had R = 55 mm. more or less and the arms are narrow as in the small paratype, but this may be due to the unusual way in which it met its death[1]. No other specimens were found.

Although there can be little doubt that this very unusual Astropecten belongs to the Monacanthus-group of Döderlein, it is easily distinguished from both *granulatus* and *monacanthus* by the armature of the inferomarginal plates, particularly the flat, truncate marginal spines, and the aboral series of spines which those plates carry. In life of course, this species can never be confused with any other.

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[1] That it was dead when found by the Stellaster is a possibility not to be ignored but its appearance when secured makes this seem unlikely.

LUIDIIDAE

LUIDIA AUSTRALIAE

DÖDERLEIN, 1920. "Siboga" Ast.: Luidia, p. 266.

While the distinction between this species and the following seems rather trivial yet since it is recognizable, apparently constant and associated with different geographical areas, it may properly be recognized in the name.

The material at hand consists of 7 typical specimens and an arm fragment, and 2 rather small specimens which seem to represent a color variety. Typical *australiae* is deep yellow or buff, more or less blotched and variegated with dull, dark green. Large specimens sometimes have the whole or nearly all of the dorsal surface dark. Mr. Livingstone has written me of a specimen he secured at Lord Howe Island during the Christmas holidays, 1932, with R = 245 mm. "Abactinal surface wholly black, actinal surface and spines cream-coloured." It "has a trace of very dark green." "It is closer to a black than to a green to my mind but may be it could be called blackish green." This is of course a very large and doubtless old specimen. The one which we took at Lord Howe in April, 1932, is not quite so large and the buff and dark shades are about equal in extent. The specimens from the vicinity of Fremantle have the dark and light shades very much mixed but the dark predominates and has a distinct greenish tinge. All of the specimens of *australiae* at hand have 7 arms but usually one (or more) of them is regenerating. There is considerable diversity in the relative size of disk and arms, the ratio ranging from R = 6r to R = 8r.

While dredging near Garden Island, off Fremantle July 22, 1932, we took two small Luidias which were so different in color from any *australiae* I have seen that I suspected they might represent an undescribed species but comparison with other Luidias fails to show any character except color by which they can be distinguished from small *australiae*. In life, the ground color was very light, almost cream-color while the blotches and markings of the upper surface were chocolate-brown, with no hint of green. The dry specimens after three years are little changed save that the brown has faded to some extent. For convenience, they may be designated as "forma *brunnea*." Each has 7 arms; in one R = 82 mm., in the other R = 110 mm.

A single arm of a small Luidia, showing the characteristic large paxillæ near the tip which distinguish *australiae* is in the collection; it was taken at Hamelin

Bay, near Augusta, W. A., January 20, 1930 by Professor E. W. Bennett, and measures 80 mm. long by 12 mm. wide at base.

Aside from this fragment and the 2 specimens of "*brunnea*" just described, the material of *australiae* at hand is as follows:

Lord Howe Island. Southeast end of lagoon beach, buried in sand, its position indicated by the radiate depression, April 3, 1932. 1 large adult.

Western Australia: Between Fremantle and Garden Island, 2–3 fms., October 14, 1929. 2 small adults.

Rottnest Island, Thompsons Bay. 1 small adult. Loaned by the Western Australian Museum.

Rottnest Island, 1934. Captain Beresford E. Bardwell leg. et don. 2 small adults.

LUIDIA MACULATA

MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 77.

It was a great surprise to discover that the Luidias taken at Broome were obviously different from those taken on the eastern and western coasts of Australia. Of course, the most obvious difference is that they have 8 arms, whereas all the other Australian specimens available have but 7. It was then noted that they lack the large paxillae near the tips of the arms, so characteristic of *australiae*, and it thus seemed probable that they should be referred to the Asiatic species and not to the Australian. Comparison with specimens from Hong Kong and Ceylon showed this to be the case.

Of the 6 specimens at hand, 1 was taken Sept. 14, 1929 in 7–8 fms. of water, on the south side of Roebuck Bay. Although brought up by a diver and handled with great care it slowly but persistently broke off all but one of its arms. In life R = 225 mm. and the following color notes were taken: "Cream color with most of disk light gray; arms marked with light bluish gray and dark greenish-gray; more or less of a line of ochre-yellow paxillæ along middle of ray and also on disk. Each pedicel white with a longitudinal orange-stripe on outer side." After eight years the dry specimen shows but very little change, except of course that the pedicels are completely dried up.

The other 5 specimens were taken in 1932, 2 near Broome, the other 3 on June 17, in Beagle Bay, by our Japanese diver, Wan. The largest specimen with R = 230 mm. was wrecked in the dredge but the second Broome specimen is in perfect condition, showing form and color as well as the day it was taken. Of the Beagle Bay specimens 2 were "light gray irregularly mottled with yellow-brown along midradial line, and with blackish laterally and terminally; marginal spines and lower surface white. Feet pale yellow with an orange longitudinal stripe." The third specimen was "uniformly deep slate gray above." Six of the arms were regenerating and those youthful tips were dark brown. In the dry specimen the contrast between these regenerating portions and the rest of the animal is still very marked. Whether the orange stripe on the pedicels is always present in *maculata* my notes fail to make certain. Even more regrettable is my failure to note whether it is present or wanting in *australiae*.

LUIDIA HEXACTIS[1] sp. nov.

Plate 17, fig. 1

Rays 6. R = at least 140 mm.; r = 15 mm.; br = 15 mm. R = rather more than 9r or br. Disk relatively small and arms slender. Paxillæ in 5 longitudinal series of close set squares with sides 1.5 mm. long, on each side of ray; between these lateral series are 5 somewhat irregular series of more polygonal and smaller paxillæ; near the tips of the arms, the paxillæ are still smaller and less regularly arranged; the paxillæ are closely covered with very fine granules none of which are at all spine-like; the arms, which are fairly high at base (8 or 9 mm.) but flattened on the upper side, are thus quite smooth. Madreporite just distinguishable close to the interradial margin.

Inferomarginal plates very short and wide; there are about 7 in 10 mm. of arm-length while their width is about 5 mm.; the surface is well covered by a longitudinal series of 2–6 spines and a large number of very much smaller spines or spinelets; the largest spine is more than 2 mm. long, wide at base but rapidly attenuate to an acute tip; it is situated on the outer end of the plate and close to it but below is generally a second spine of almost equal size; the remaining spines, when present, are well spaced, and on the basal half of the arm, one, often the smallest is at the inner end of the plate; the spinelets are very slender and acute and most of them are less than a millimeter in length, often much less.

Adambulacral armature simple, with 2 large furrow spines and 2 on surface of plate; outer furrow spine 2–3 mm. long, strongly compressed, straight, tapering to a blunt point; inner spine not so long, curved, markedly acute; the 2 spines on surface of plate are situated side by side, 2 mm. long (or less), tapering to a slender point; back of them is a large pedicellaria, often accompanied by a much smaller one; occasionally there are 3 pedicellariae on a plate; pedicellariae made up of two long, slender jaws with 1 or 2 or several slender, sharp spinelets at their base. Actinolateral plates only 2 on each side, but each carries a very large pedicellaria. Oral plates with 7–9 long marginal spines, 5–7 long spines on the crest, and a few small spines or pedicellariae on the inner end; usually 2 pedicellariae composed of 4 or more short spinelets on the side of each oral plate, deep in the mouth.

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[1] ἕξ = *six* + ἀκτίς = *ray*, in obvious reference to the number of rays.

Color of oral surface very light, probably white or cream-colored in life; dorsal surface light buff blotched and marked with large irregular areas of dull, dark greenish-gray. Apparently the color in life was much the same as, and very similar to that of *L. maculata*.

Holotype, M. C. Z. no. 3134, collected "on a sandbank near Montgomery Reef, more or less in Collier Bay, between Cockatoo and Augustus Islands," northwestern Australia, by Captain Beresford E. Bardwell, in October, 1933. There is with it a note by the collector "This was half dead and badly broken when discovered."

This is a very well marked species for while it seems to belong to Döderlein's Quinaria-group, it is very unlike the only 6-armed species, *penangensis*, in its paxillæ and dorsal surface, and is not near any of the 5-armed species. It seems to be nearest to *forficifera* but aside from the difference in the number of arms, the difference in the armature of inferomarginal and adambulacral plates is conclusive. The possibility that *hexactis* is simply a 6-rayed *maculata* is debarred by the differences in the pedicellariae and in the armature of the inferomarginal plates.

ARCHASTERIDAE

Archaster typicus

Müller and Troschel, 1840. Monatsb. Preuss. Akad. Wiss., p. 104.

There are six good specimens at hand of this well-known East Indian seastar. They were given me by Mr. Melbourne Ward who collected them at Lindeman Island, on the Barrier Reef, near Port Mackay, Queensland. This is by far the most southern station at which the species has been taken. The present specimens are of moderate size (R = 60 mm., more or less) and closely resemble individuals of similar size from the Caroline Islands.

ARCHASTER LAEVIS[1] sp. nov.

Plate 17, fig. 2

R = 105 mm.; r = 13 mm.; br = 14 mm.; hence R = about 8r or br. In life and in the better-preserved specimens, the disk and arms are high (in the holotype, 10 mm.) and the aboral surface is perfectly flat except beyond the middle of the arms where it gradually declines to the terminal plate. Paxillae very close set, the tops sharply hexagonal, excepting some large ones on disk, particularly near madreporite, and a series of small circular ones adjoining the superomarginal plates on each side of each arm; largest paxillae of disk each have 40 or more, angular, truncate, but often slightly convex, granules on the surface and about 30 similar ones around the margin; there is no essential difference between the marginal and the surface granules; near the disk margin and on the arms, the paxillae are much smaller; on each arm is a median series which is conspicuous the paxillae-tops are so short and wide, less than a millimeter long and fully 2 mm. wide; there are about 25 granules on such a top; on each side of the median series are five longitudinal series of hexagonal paxillae and a sixth less regular series of smaller, nearly circular ones bearing only 6–10 granules; the hexagonal paxillae carry about 10–15 (or more) granules of which only 1–6 are central, the others marginal. No pedicellariae have been detected.

Superomarginal plates about 53 in each series, placed vertically along the sides of the rays except near the tip where they encroach more and more on the upper surface, the distalmost pair sometimes coming in contact in the midline at the base of the moderately large terminal plate; at the base of the arms, the superomarginal plates are 6 mm. high and 2 mm. wide (i.e. long.); there are no spines on the superomarginal plates but they and the terminal plates are closely covered with coarse granules like those borne on the paxillae of the distal part of the arm. Madreporite large, 4 mm. in diameter, and 5 mm. from the disk margin.

Inferomarginal plates of about the same number as the superomarginals, but their width (corresponding to height of superomarginals) is considerably less, those at base of arm being about 5 mm. wide; plates completely covered with wide, flat spinelets, having rounded tips; on outer margin of plate are 2 short (less than 2 mm.), flat, wide, round-tipped spines, which project very little from the side of ray but are somewhat appressed to it (on some plates, particularly at tip of arm, only one spine is present); below these 2 inferomarginal spines are several (1–4) somewhat similar but smaller spines which intergrade with the spinelets covering the plate.

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[1] *laevis* = smooth, in reference to the close-set and even paxillæ, which give a notably smooth dorsal surface.

Adambulacral plates with an armature of 6–8 (usually 7) spines, a rather slender but blunt furrow spine, 2 similar but somewhat stouter marginal spines and 2 pairs of surface spines; the inner pair is blunt but not much flattened, the outer is larger and quite flat and the adoral is distinctly the largest spine on the plate. Oral plates conspicuous with about 9 moderately stout blunt spines on the furrow margin, about 4 on the posterior margin and a double series on the crest with 8–10 similar but shorter spines.

Color in life: "Oral surface, inferomarginal spines and madreporite cream white; upper surface chiefly yellow-brown variegated with light fawn-gray which becomes almost cream-white near tips of rays; an indistinct dull blue-gray line 1.5 mm. wide along the middle of each arm, extending onto disk but not clear to center." The dried specimens have lost their distinctive and handsome coloration; and are now a dull light yellow brown very indefinitely variegated with darker; in some cases the darker shade predominates; in a particularly well-preserved dry specimen the light yellowish brown shade includes most of the sea-star but the margins of the rays near the base and scattered groups of superomarginal plates are a dull reddish with a hint of purple; these reddish areas are ill-defined and merge into the yellow-brown ground color. Specimens dredged near Fremantle showed essentially the same coloration as those from Lagrange Bay but the tints were slightly different; the fawn-gray was almost a dull light purple.

Holotype, M. C. Z. no. 3135, from the vicinity of Broome, W. A., 5–8 fms.

That this handsome Archaster is nearly related to *A. angulatus* admits of no doubt, but the smooth tesselated aboral surface caused by the crowded, truncate prismatic granules of the paxillæ gives it a very characteristic appearance quite unlike that of any specimens of *angulatus* available for comparison. It is possible however that carefully preserved specimens of *angulatus* would more nearly resemble *laevis* and that the latter is only an extreme form of the older species. Whether there are color differences of importance remains to be determined as no information as to the color of *angulatus* is available.

This fine sea-star is not uncommon in shallow water, on the sandy coast of northwestern Australia but we did not find it near low tide mark or in tide-pools. It was a surprise to meet with it again near Fremantle, while dredging between that port and Rottnest Island, but no differences worthy of note have been detected between the specimens taken in these widely separated areas.

The form of dry specimens, especially large ones, is apt to undergo considerable change in the process of preservation; the paxillar field of the rays becomes much narrower and sinks below the level of the superomarginals especially in the midline, and the upper ends of the superomarginals themselves are drawn inward by this shrinking so that those plates no longer form a vertical wall at sides of the rays but lie rather considerably on their aboral surface. There is little diversity of form among living specimens but young ones of course have the rays relatively shorter; thus the smallest specimen at hand, with R = 23 mm. has r and br about 5 mm. so that R is only equal to 4.5 r or br. In adults there is some difference in the slenderness of the arms; thus the largest individual, with R = 122 mm. has br = 18–20 mm. so that R is little more than 6 br, but the great majority have R in excess of 7 br.

The 26 specimens at hand are from the following places:

Western Australia: Vicinity of Lagrange Bay, 5–7, fms., on bottom of sand and shells, September 11, 1929. 2 specimens.
Vicinity of Roebuck Bay and southwestward 5–8 fms. June, 1932. 20 specimens, adult and young.
Between Fremantle and Rottnest Island, 8–10 fms. October 19, 1929. 4 specimens.

GONIASTERIDAE

NECTRIA MULTISPINA

H. L. CLARK, 1928. Rec. S. Austr. Mus., **3**, p. 375.

It was a real disappointment not to see Nectria alive or even freshly killed, but all of the sea-stars of that genus in the present collection were given to me by Professor E. W. Bennett. One of them is an indubitable specimen of this South Australian species, with R fully 75 mm. It is in fairly good condition but is somewhat waterworn. It is "one of many" found in "drift on the sand beach at Middleton Beach," near Albany, W. A., "about Christmas, 1929." The color when collected was "(1) orange (2) red"; presumably this means that the lower surface was orange and the upper red; there is no trace of these colors now. It is interesting to learn that the range of this well-marked species extends so far west as Albany.

NECTRIA OCELLATA

PERRIER, 1876. Arch. Zool. Exp., **5**, p. 4.

Professor Bennett has also given me 2 specimens of this Nectria, which were taken by Mr. D. L. Serventy, "in a single haul of otter-trawl (trawler "Bonthorpe") in 90 fms., 33° 15′ S x 126° 22′ 15″ E, on February 23, 1930." This locality is in the western end of the Great Bight and is the furthest west I believe that this species has been taken. In life these two specimens are recorded by Mr. Serventy as "chestnut-orange" but they are now so completely bleached as to be a dirty white. One has R = 70 mm., r = 22 mm. and br = 24 mm., so R is about 3 r or br. In the smaller specimen, R = 54 mm., r = 20 and br = 17, so R = 3br but not quite 3r.

TOSIA AURATA

GRAY, 1847. Proc. Zool. Soc. London p. 80.

The only specimens of this characteristic Australian sea-star in the present collection are 2 dredged in Ralph Bay, Hobart Harbor, Tasmania, in 2–3 fms., November 15, 1929. In life the coloration was much like that of the more common *australis*; variegated with fawn color and brown above, grayish fawn and brown below; they are now "museum color." The larger has R = 49 mm., the smaller, 43 mm.; R = 1.5r in both.

TOSIA AUSTRALIS

GRAY, 1840. Ann. Mag. Nat. Hist. (1), **6**, p. 281.

The only specimen at hand of this common sea-star which is a typical *australis* was dredged on the west side of Hobart Harbor, Tasmania, in 2–3 fms., Nov. 15, 1929. It is small with R only 19 mm. and r about 13. In life the color was deep brown above, variegated with fawn color, and cream-color below variegated with brown; these shades are all quite lost now.

All of the remaining Tosias are from Western Australia, 6 from the vicinity of Fremantle and 3 from Bunbury and all represent the form *astrologorum*; those from Bunbury are somewhat nearer typical *australis*. These were dredged in 5–8 fms., in Koombana Bay, October 26, 1929; they were "variegated light and dark brown," and are all rather small. The largest individual secured anywhere was found under a stone at Point Peron and was quite different in color from the others; it was variegated with dark and light gray, the light shade with a bluish tint; it has R = 31 mm., r = 20 mm.; 9 of the distalmost superomarginals are very large but the tenth is replaced by 3 small plates. The 5 remaining specimens were found on the wharf-piles of an old jetty at Garden Island. It was a great surprise to me to find so rigid and inert a sea-star active enough to climb a wharf pile and able to cling closely to its surface. It was a severe blow to the idea conceived *a priori* that Tosias must live lying flat on the bottom!

In the National Museum at Melbourne there is a remarkable *Tosia australis* of the typical sort which is perfectly tetramerous with only 24 superomarginal plates.

PENTAGONASTER DUBENI

GRAY, 1847. Proc. Zool. Soc. London, p. 79.

Among the rocks at Point Peron, W. A., in October, 1929, four specimens of a Pentagonaster were taken which may properly be referred to this species, since Gray gives Western Australia as the type locality for *dübeni*. It is interesting to note however that all of these specimens from Point Peron have the arm-tips wide and rounded and the terminal superomarginal on each side enlarged and swollen in varying degrees, whereas Gray's figure (1866, pl. 3, fig. 2) shows little indication of these features. On the other hand a specimen from South Australia in the M. C. Z. is almost exactly like Gray's figure while specimens from Port Jackson are intermediate some approaching the Point Peron specimens rather closely. It is evident that in this species as in the genotype, *P. pulchellus* from New Zealand, there is a tendency towards the development of two extremes — one having relatively unenlarged superomarginals distally, while in the other the distal superomarginals are greatly enlarged and swollen. As no correlation has yet been discovered between these extremes and their habitat or distribution varietal names are hardly worthwhile, although they would be as valid as the form "*astrologorum*" of *Tosia australis*, which represents a similar tendency to enlargement, or at least swelling, of superomarginal plates.

The specimens of *dübeni* from Point Peron range in size from R = 26 mm. to R = 38 mm.; in all r is about equal to one half R. The largest has but 32 superomarginals, as there are 4 superomarginals on only 2 rays and on those rays only on one side. In a second specimen there are 44 superomarginals; on only one side of one ray is the number as small as 3; on the other side of that ray are 6 superomarginals but three are abnormally small and 2 are irregularly placed; on another ray, a large superomarginal is crowded out of the left-hand series onto the upper surface of the arm and separates the terminal plate from the aboral plates of the ray; this specimen shows less conspicuous abnormalities on the oral surface. The two remaining specimens are smaller and both have the normal number of 40 superomarginals.

This is a very pretty sea-star in life as the upper surface is bright colored and the separate aboral plates are outlined in fawn-color, cream-color or white. Two of the Port Peron specimens were yellow-orange, one was bright vermilion red and one, the largest, was a deeper red. They were found under rocks, or in plain sight, on the sides of rocks.

GONIODISCASTER AUSTRALIAE

Plate 8, fig. 2

TORTONESE, 1935. Boll. Mus. Univ. Torino, **45**, Series 3, no. 60, p. 3.

This is one of the most beautiful of the many fine sea-stars of northwestern Australia and is not at all uncommon in the vicinity of Broome, but it was not found in less than 5 fms. of water. Owing to its striking coloration it is often brought up by the divers of the pearling fleet. Of the 16 at hand, the smallest has R = 33 mm., r = 10 and br = 10, therefore R = 3.3r or br; the largest has R = 92 mm., r = 35 and br = 34, so that R = 2.6r or br. But the rays are sometimes much more slender; in a specimen with R = 67 mm., R = 3.3r and 3.75br. Obviously, there is more or less diversity in form but this is not so striking as the difference in color shown by individuals quite similar in size and form. Most commonly, the characteristic color is a deep rose-pink, particularly on the marginal plates; usually in adult specimens the abactinal surface develops more or less green pigment; in some individuals however this pigment is gray and not at all green and may completely mask the pink. A specimen taken June 14, 1932, north of Broome is described in my field notes thus: "a lovely gray with black tips to arms and an indefinite blackish area at center of disk; hints of green in interradial areas. No pink. Lower surface light cream. Dried pink!" The colors disappear rapidly after drying, the green and gray being particularly evanescent; the pink lingers more or less for weeks and months; some specimens still show, after five years, distinct indications of it on the marginal plates and especially at the arm tips.

While this species is undoubtedly near to *scaber* (Möbius), I think Tortonese is correct in considering it distinct. Even those specimens with the shortest, widest arms have them longer and narrower than in *scaber* and the superomarginals are definitely more numerous. There is considerable individual diversity in the number of pedicellariae present.

Curiously enough Tortonese makes no reference to the following species (*coppingeri*) which is undoubtedly the nearest relative of *australiae*. Probably he considered Bell's species identical with *forficulatus* Perrier, as does Döderlein (1935), an opinion with which I cannot agree, as shown below.

It is unfortunate that Döderlein (1935) introduces a new name, *australis*, for a Goniodiscaster, allied to *porosus* Koehler, which he calls a "nov. forma" and diagnoses in 5 words! It is very different from *australiae* Tortonese. The latter name was published in July, Döderlein's in October, but as they are differently spelled both can be used if it is necessary.

GONIODISCASTER COPPINGERI

Pentagonaster coppingeri BELL, 1884. "Alert" Rep., p. 128.
Goniodiscaster coppingeri H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 110.

Mr. Melbourne Ward dredged near Lindeman Island, Great Barrier Reef, July-September, 1934, 2 large individuals of this apparently rare sea-star, which he has kindly sent to me. In them R = 80–85 mm., r = 26–27 mm.; hence R = 3r; br is not equal to r. These specimens resemble so closely Bell's description, save in one respect, that I have no doubt of their identity, especially since one of his specimens came from Port Curtis. They are exactly like the specimen from Mt. Adolphus Island, Torres Strait, figured in my Torres Strait Report (1921). The one particular in which these specimens differ from Bell's description is in the minor radius. Bell says that in his larger specimen r = 46 mm. and br = 24 mm. If that were correct, R = 2r, which would make the form of his specimens quite out of keeping with his description. Moreover he says that in the smaller specimen R = 82, r = 26 mm. Now one of the specimens at hand is exactly this size and br also is 26 mm. Thus r and br are equal which is approximately true in very many sea-stars. There seems no doubt that the figures 46 and 24 are both typographical errors or slips of the pen. Probably each should be somewhere between 28 and 32, for the long narrow arms, R 3–3.5r, is a striking feature of the species.[1]

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[1] Since the above was written Mr. Dilwyn John of the British Museum has very kindly remeasured Bell's specimens. He confirms the measurements of the smaller but states that in the larger, r 33 mm. not 46. He also enclosed a sketch showing where on the arm "br = 24 mm.," which indicates that according to my way of measuring br = 30 mm. or more, as would be expected.

Döderlein (1935) inclines to believe that *coppingeri* is a synonym of *forficulatus* Perrier. To this I cannot agree. Koehler (1910) has given figures and a detailed description of Perrier's species and one of the largest of Koehler's specimens is at hand (M. C. Z., No. 2094). Fisher (1919, p. 325) has discussed some of the details of this specimen and doubts if it is a typical *forficulatus*, but this does not matter for the present discussion, since its peculiarities have nothing to do with the main differences between Perrier's and Bell's species. These differences are in the shape of the rays and in the number of superomarginals. Bell's species is in these particulars very near the preceding (*australiae*) and I have compared specimens of that species, having R = 33 mm. and 48 mm. respectively, with the *forficulatus* mentioned above which has R = 40 mm. (No. 2094). The differences are obvious. The Australian specimens have a much smaller disk and longer, narrower arms, with narrower, more numerous superomarginals. Thus in the *forficulatus* with R = 40 mm., the breadth of the arm at base is 15 mm. (R = 2.66br), and there are 12 superomarginals on each side of each ray with a thirteenth indicated. In the Australian specimens, R 3–3.5br, and there are 15 or 16 superomarginals in the smaller specimen, 18 or 19 in the larger. The granulation of all the plates in the two Australian species, regardless of size, is distinctly less coarse than in *forficulatus* and the armature of the adambulacral plates is made up of shorter and less heavy spines, particularly in the surface series.

There seems no doubt that *forficulatus* approaches the group of Goniodiscasters with shorter wider arms, such as *granuliferus* (Gray) and *porosus* (Koehler), while the Australian species belong rather to a group with arms approaching in form to those of Paragonaster. The type of the genus, *pleyadella* (Lamarck), is intermediate between the two groups, each of which might be treated as a genus if the number of species involved were large enough to make such a division convenient.

As for the differences between *coppingeri* and *australiae*, they are obvious enough when specimens are side by side. The west coast species has a much rougher dorsal surface with many coarse granules and small pointed tubercles on the aboral plates and even on the superomarginal plates. These are not very conspicuous in Tortonese's published figure but are well shown in his original photograph, of which he sent a copy to Fisher who has kindly given it to me. In most well preserved specimens, the rough, almost "prickly" upper surface contrasts markedly with the almost smoothly granular surface of *coppingeri*; in one of the specimens of the latter from Lindeman Island, a few low tubercles are present on many superomarginals but they are not nearly so numerous or noticeable as in *australiae.* Orally the two species are so much alike it is doubtful if a constant difference can be found. The specimens of *coppingeri* at hand indicate that the color in life was darker than that of *australiae,* an almost brick red. Information on this point is greatly to be desired.

Goniodiscaster foraminatus

Goniodiscus foraminatus Döderlein, 1916. Zool. Jahrb.: Syst., **40**, p. 415.
Goniodiscaster foraminatus Döderlein, 1935. "Siboga" Ast.: Oreasteridae, p. 79.

An interesting young Goniodiscaster loaned by the museum at Perth (No. 9018) may well be referred for the present to this species, the type-locality for which is Shark Bay. In this specimen $R = 35$ mm. while r and br are approximately half as much. The present "museum-color" is very light, cream-color orally and pale yellowish-brown above. The resemblance to Döderlein's figures is very close. In only one particular does this young individual fail to qualify for the Shark Bay species; the pedicellariae are not at all numerous or conspicuous. Since this may be either a youthful character or an individual peculiarity, we are justified in considering this specimen a young *foraminatus.* It was collected by Mr. K. Barker at Garden Island, off Fremantle, in 1915.

Müller and Troschel's species *G. seriatus,* with which Döderlein considers Gray's *Pentaceros granulosus* synonymous, comes from southwestern Australia but the Garden Island specimen is quite certainly not a young example of that species. The form and proportions and the granulation of the aboral plates are very different from those characters in *seriatus* and these differences can hardly be associated with the youthfulness of the specimen.

Goniodiscaster integer

Livingstone, 1931. Rec. Austr. Mus., **18**, p. 135.

Five little sea-stars taken at Lindeman Island, Barrier Reef, in 1934 and sent to me by Mr. Melbourne Ward, apparently represent this species but I am not satisfied as to whether it is really distinct from *pleyadella.* However until the contrary is shown, the name *integer* may conveniently be used for the form occurring on the eastern coast of Queensland, since adults are easily distinguished. A typical adult is readily told from an adult *pleyadella* by the tapering rays, smaller, less sunken papular areas, and more irregular, coarse granulation. But young individuals of *pleyadella* to a size of R = 32 mm. bear little resemblance to the adults, as Döderlein's (1896) figures show, and apparently the two species, if species they be, cannot be certainly distinguished from each other until R = 40–50 mm.

The present specimens have R = 6, 10, 15, 26 and 31 mm. respectively. The 3 largest show the 5 primary radial tubercles plainly but they are most conspicuous in the individual with R = 26 mm. This specimen is also much the lightest colored, a brownish cream-color; the others are light brown. There is nothing of importance to add to Livingstone's careful description.

GONIODISCASTER ACANTHODES[1] sp. nov.

Plate 5, fig. 2

Rays 5. R = 73 mm., r = 37 mm., br = 35 mm.; R = 2r or 2br. Aboral surface slightly arched, covered with numerous plates of moderate or small size, hidden by a coat of granules and pedicellariae; most of the plates also bear one or more rounded tubercles of diverse sizes, the largest more than a millimeter in diameter and fully as high; on each ray there are 3 parallel series of these tuberculated plates, the median being shut off from the terminal plate by the meeting of superomarginals, while the lateral series drop out somewhat sooner. Pedicellariae fairly numerous, square-jawed, longer than wide or high, very unevenly distributed among the granules. Granules of very unequal size, more or less rounded. Papulae few and small on the disk becoming much more numerous and larger on the rays where, in groups of 4–7, they form 3 (or 5) (5 or 7 basally) ill-defined series, not sharply distinguished from each other.

Superomarginal plates 11 (or 12) on each side of each ray; the interradial pair lie nearly flat on aboral surface of disk and measure about 10 mm. wide by 4 mm. long but the inner end is clearly longer than the outer. Distally the plates are longer and not so wide, and lie more on the side of the ray; the tenth is only 7 mm. wide while its outer side is 5 mm. long and 3 mm. high. The plates are covered with a very close smooth coat of granules, smallest on the lateral margins and coarsest at the inner end; in addition, the plates carry 1–12 rounded tubercles of very diverse sizes, like those on the aboral plates, irregularly distributed but chiefly near the inner end. Terminal plate relatively small, covered by granules like those of the superomarginals.

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[1] ἀκανθώδης = *full of thorns*, in reference to the numerous tubercles on the aboral surface.

Oral surface flat, the actinal intermediate areas rather large, covered by a closely matched pavement of 50 or more polygonal plates, 2–5 mm. in diameter; the granules and pedicellariae covering these plates are much longer and less crowded than those of the upper surface; the innermost series of actinal plates extends out to the seventh inferomarginal but the adjoining series only reaches the fifth. Inferomarginal plates correspond in number and position (not exactly) with the superomarginals, but there is an additional very small inferomarginal (or usually 2 of them) just below the terminal plate where the tip of the ray turns up; there is no superomarginal to correspond with these; granular coat of inferomarginals close and even but coarser than that of the upper series — not so coarse however as that of the actinal intermediate plates; a few small tubercles may be found on one or more of the distalmost inferomarginals.

Adambulacral armature in three distinct series; innermost of 5 (4–6) strongly compressed spines (2 mm. long, more or less) with rounded tips, the middle ones longest, the outermost very small; the second series consists of 2 (or distally only 1) very broad, stout spines (.75–1.50 mm. wide) with truncate (or rounded) tips; the outermost series consists of 2 or 3 short, thick spinelets, not so high or so big as those of the second series; this outermost series tends to be irregular in its distribution and may be lacking on some plates. Pedicellariae, with jaws much longer than wide, occur on many adambulacral plates, often being placed on the adoral margin between the first and second series of spinelets. Oral plates with a heavy armature; about 10 very stout prismatic or squarish spines with rounded tips crowd each margin; back of them is a second series of 6, even stouter, but shorter and less prismatic spines; on the inner crest of each plate is a series of 4 or 5 much smaller, very short spines.

Color in life very striking; marginal plates, tubercles and coarsest granules bright brick-red, the rest of the aboral surface bluish-gray; lower surface yellowish. All the colors disappear rapidly in preserved material. The dry holotype is a dull reddish-brown above, a lighter and less reddish color below; the rays are lighter than the disk aborally.

Holotype, M. C. Z. no. 3154, dredged southwest of Broome, in 7–8 fms., June, 1932.

The selection of a holotype has been a difficult matter owing to the great diversity in the development of tubercles and spinelets on the aboral surface. Orally there is individual difference in details, particularly in the size, proportions and number of the spines in the outermost adambulacral series, but no essential modifications have been noted. The differences aborally may be grouped under four heads. 1. Tubercles on superomarginal plates: these, so evident in the holotype, are lacking in most specimens, the superomarginals being as smoothly coated as can be; only 3 specimens altogether have these tubercles. 2. Tubercles on aboral plates: the diversity in these is surprising and does not seem to be correlated in any way with size; they are largest and most spherical in the holotype; in a somewhat smaller specimen they are nearly as large but are conical and more numerous and stand out with great distinctness from the granules which cover the plates; in a third specimen, they are somewhat conical but on most plates there is only one or one is conspicuously bigger than the others; in a fourth specimen, they are small but numerous, many plates having 10–15 nearly spherical tubercles in a not very compact group; other specimens have very few tubercles and these confined to the plates of the disk and the carinal plates at the base of the rays; the smallest specimen (R = 37 mm.) has very few tubercles and a specimen with R = 42 mm. has none at all on either aboral plates or superomarginals. 3. In about half the specimens, a conspicuous tubercle noticeably larger than its fellows is found on the large carinal plate at the base of each ray; in no specimen are these symmetrically developed; usually they are evident only at the base of three or four rays; in one case, a specimen with R = 47 mm., all 5 are present but one is accompanied by a second tubercle nearly as large; when most conspicuous these tubercles may be 2 mm. high and more than 2 mm. in diameter at base; ordinarily they are bluntly conical but they may be rounded, or terminate in 2 or 3 slightly indicated blunt points. 4. While the holotype and many other individuals have the rays wide and rounded at tip, in half a dozen individuals the rays are distinctly pointed, and other specimens intergrade between the extremes.

In spite of this interesting diversity, I have no doubt as to the specimens representing a single species. All were collected by me and showed the striking and characteristic coloration in life which distinguishes this handsome sea-star. Owing to the difference in the matter of tubercles on the superomarginal plates, some specimens of *acanthodes* fall into one section of Döderlein's recently published (1935, p. 77) key to the species of Goniodiscaster while others fit into the alternative section. The holotype runs down at once to *G. scaber* Möbius but comparison with the figures given shows it is not that species, the number of superomarginals and their granular coating being obviously different. Individuals of the present species, lacking superomarginal tubercles run down to *seriatus* M. & T. or *granuliferus* Gray, but again comparison with the figures given by Döderlein shows that the Australian species is quite distinct. The remarkable constancy in number of superomarginals in *acanthodes* is worthy of special mention; the smallest specimens have 11 or 12, the largest has 11 normally developed and a twelfth just forming next to the terminal plate, and other large specimens have 12, with exceptionally a thirteenth just forming.

All of the 24 specimens at hand were dredged on a firm, sandy bottom in 7–8 fms. of water in the vicinity of Broome, in June, 1932. Oddly enough we did not meet with the species in 1929.

GONIODISCASTER BICOLOR[1] sp. nov.

Plate 5, fig. 1

Rays 5. R = 80 mm., r = 40 mm., br = 40 mm. R = 2r or br. In all details of structure like those specimens of the preceding species (*acanthodes*) which lack tubercles on the superomarginal plates; no details of tuberculation, spinulation, granulation, form, size or proportion, have been discovered by which the two forms can be separated. The granulation in *bicolor* is a little finer, especially on the marginal plates, when specimens of like size are compared side by side, but the difference is so slight it cannot be expressed in words or figures so as to help in determining to which species an unidentified specimen belongs. No specimens of *bicolor* however have any conspicuous tubercles on the superomarginal plates.

The coloration of the present form is so strikingly different, and in each species the coloration shows so little diversity, that it never even occurred to me when collecting them that the two were very closely allied. Not until the dried material was unpacked in Cambridge did I realize how very much alike the two forms are. The present species (*bicolor*) has the disk and bases of the rays uniformly gray with no hint of blue in it; the remainder of the ray is a very fine rose-red, quite different from the red of the marginal plates in *acanthodes*. Madreporite pinkish and a few dots near center of disk deep rose-red.

This lovely sea-star was much less common than *acanthodes* and only 7 specimens were taken. The first were found in Lagrange Bay but others were taken nearer to Broome. Unfortunately my field notes do not make clear whether the two species were ever taken together. The smallest specimen of *bicolor* taken has R = 58 mm. The largest is the holotype (M. C. Z. No. 3156) whose measurements are given above.

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[1] *bicolor* = having two colors, in reference to the striking coloration.

The objections to basing species of sea-star on color are so obvious as to require no amplifying, but the present case is so extraordinary I have been at a loss as to what the best course might be. To designate one as a color phase of the other involves the difficulty of determining which is the original "species" and which is the "form"! That one is the male and the other the female of a single species is conceivable, and deserves investigation when fresh material is available, but no such remarkable case of sexual dimorphism in color is known at present among echinoderms, and seems highly improbable in this case. It seems best therefore to give each form a specific name, in spite of the difficulty of distinguishing museum material. As a matter of fact, the dry specimens of *bicolor* cannot all be distinguished beyond question from the corresponding material of *acanthodes* but as a rule the interradial superomarginals are slightly lighter colored than those on the arms while this is not the case in *acanthodes*.

STYPHLASTER[1] gen. nov.

Allied to Goniodiscaster but readily distinguished by the coarse, polygonal, flat-topped granules of diverse sizes which cover the papular areas of the aboral surface, contrasting markedly with the large spherical granules which cover the convex skeletal plates. Marginal plates notably convex and covered with very coarse, spherical granules; the distal inferomarginals extend out laterally beyond the superomarginals so that they are conspicuously visible from above and form the margin of the distal half of each ray. Adambulacral armature in 4 crowded series of very heavy spines, the furrow series stout and similar to the others but not so large; outermost series, small, prismatic and truncate. Pedicellariae apparently wanting.

Genotype, *Styphlaster notabilis* sp. nov.

This is a well-marked genus, for while its relationship to Goniodiscaster is obvious enough, the general facies is quite unlike any member of that genus. The whole abactinal surface is well-arched, considerably above the marginal plates, but the basal part of each ray is conspicuously arched above the interradial areas as well as above the somewhat flattened central pentagon of the disk itself.

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[1] *στυφλός* = *rough, rugged* + *ἀστήρ* = *a star*, in reference to the unusually rough and rugged appearance of the aboral surface.

STYPHLASTER NOTABILIS[1] sp. nov.

Plate 17, figs. 3–4

Rays 5, short and stout, high at base. R = 57 mm., r = 28 mm., br = 26 mm. R is thus about twice r or br. At tip, each ray is wide and rounded; 10 mm. from tip, the width is 18 mm., the height, 8 mm.; nearer tip the height is a full 9 mm., while at base, say 20 mm. from disk-center, it is 15 or 16 mm. At center, the disk is 13 or 14 mm. thick. Aboral plates rhombic, polygonal or rounded, rather sharply defined, and markedly convex; the center of each plate is occupied by a cluster of large spherical granules, the marginal ones smallest; one of the central ones is often conspicuously larger than the others and may become a considerable tubercle oftentimes higher than thick; on several of the carinal plates, in each series, these central tubercles become stout erect spines, but they are erratic in distribution and very unequal in size; the largest are about 2 mm. high, 1–1.5 mm. in diameter and very blunt. Margins of plates, and papular areas, covered with flat-topped polygonal granules of diverse size and form. Madreporite distinctly pentagonal, wider than high; width slightly more than 5 mm., height slightly less; distal angle 11 mm. from superomarginal plates. No pedicellariae have been detected.

Superomarginals only 8 on each side of each ray, rather conspicuously convex and covered along the margins with flat-topped polygonal granules, and elsewhere with large spherical granules, particularly large on the upper end of the interradial plates, where they are a millimeter or more in diameter; at the tip of the ray the superomarginals lie largely on the upper surface of the ray, the last pair, which are about as wide as long, being broadly in contact, and separating the small terminal plate from the aboral surface of ray.

Actinal intermediate plates about 42, in three quite distinct series; back of the oral plates is a single tetragonal or pentagonal plate and from this there extends, adjoining the adambulacrals, a series of 13 rounded pentagonal or roughly circular plates, progressively smaller distally, as far as the seventh inferomarginal; a second series of 5 or 6 similar plates extends to the third inferomarginal, and a third series of two or three plates (4 or 5 plates altogether) fill the remaining space; all of these actinal plates are somewhat convex and covered with granules similar to those on the inner end of the inferomarginals; no pedicellariae have been detected.

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[1] *notabilis* = notable, of obvious significance.

Inferomarginals 11 on each side of each ray; these plates are much more flattened than the superomarginals and nos. 4–7 exceed in size those of the upper series; all, except the two distalmost, which are very small, are wider than long; the first 5 correspond in position with the superomarginals; the sixth is less distal, the seventh and eighth underlie the seventh of the upper series, while the ninth, tenth and eleventh, underlie the big eighth superomarginal; beginning with the fourth the inferomarginals are visible from above and the seventh and eighth are particularly conspicuous, extending out at least 2 mm. beyond the upper series. (This is not due to flattening in the drying of the specimen, which has undergone practically no change since it was collected except the slight fading and dulling in coloration.)

Adambulacral armature very stout and crowded; each plate carries four series of spines; marginal (or furrow) series consists of 4 subequal spines, 2 mm. long, less than a millimeter thick, rounded at tip, the middle pair nearly cylindrical, the others distinctly flattened; second series, 3 very stout, rounded, prismatic, spines with rounded tips, the middle spine slightly the largest; third series, 3 smaller, more prismatic and more truncate spines, the middle one much the largest; outermost series, 3 or 4 (rarely 5) small prismatic, truncate spinelets irregularly arranged to cover the rest of the plate. Armature of oral plates, a direct continuation of the adambulacral armature; hence each pair of plates is densely crowded with about 35 stout spines, corresponding perfectly in arrangement with those of the adambulacral plates.

Color of dry specimen, a light reddish-brown with a lavender cast; areas between the marginal plates and between those of the aboral surface very light, almost cream-color, except on the swollen basal portion of each ray; madreporite brownish-yellow; orally the reddish-brown of the marginal plates is evident but the interradial areas and the oral and adambulacral armature is more yellowish-brown. My field notes describe the color in life as follows: "Coloration indistinctive. Lavender-brown; disk and inferomarginals, which show clearly on distal part of arm, are more brown; superomarginals more lavender. Madreporic plate, lavender-white. Sutures between all abactinal plates, whitish. Lower surface, flesh-color to reddish, the interradial inferomarginals being quite flesh-red, though dull. Adambulacral armature, creamy-white."

Holotype, M. C. Z. no. 3158, taken near entrance to Roebuck Bay in 5–7 fms., June 27, 1932. This notable sea-star was obviously a novelty and we dredged repeatedly at and near the place where we found it in the hope of securing more specimens, but in vain — the holotype is still unique.

ICONASTER LONGIMANUS

Astrogonium longimanum MÖBIUS, 1859. Neue Seesterne, p. 7.
Iconaster longimanus SLADEN, 1889. "Challenger" Ast., p. 261.

The occurrence of this remarkable sea-star on the northwestern coast of Australia is of great interest. We did not meet with it at any point but the Western Australian Museum has a fine specimen (No. 2982) taken at Broome. In it R=61 mm. and r=18 mm. It agrees in all essentials with 2 larger specimens from "Adolphus Island near Cape York" received many years ago at the M. C. Z. from Ward's Natural Science Establishment, Rochester, N. Y. These were collected by Mr. Henry A. Ward during his visit to Torres Strait and the Great Barrier Reef in 1896. In the larger specimen, R=110 mm., r=28 mm.

A photograph of a living specimen, taken by Mr. Archie Embury at Norwest Island, Capricorn Group, Queensland, lies before me, accompanied by the following notes on the color in life, which deserve publication: "Arms and marginal plates light orange-brown. Interradial areas reddish-brown. On each side of the median series of radial plates, a cream-white line, not reaching to center of disk. Lower surface, buffy-yellow."

Mr. Melbourne Ward has kindly sent me 2 small specimens of Iconaster from Lindeman Island, Barrier Reef, which he collected in 1934. They are dry and light gray-brown in color. One is a symmetrical individual with the 5 rays, 35 mm. long, while the other is a smaller but perfectly tetramerous specimen, not quite symmetrical however; one ray is only 25 mm. long and has 12 superomarginals on each side; opposite it, the ray is 27 mm. long and has 13 superomarginals on each side; if the short ray is considered anterior, the ray at its right is also 27 mm. long but has 12 superomarginals on its anterior side and 13 on the posterior; the fourth ray is 28 mm. long with 13 superomarginals on each side.

ANTHENOIDES DUBIUS[1] sp. nov.

Plate 17, figs. 5–6

Rays 5, slender and flat. R=18 mm., r=6 mm., br=5 mm.; hence R=3r and 3.6 br. Aboral surface covered by a thin, rather sparsely granulated skin; granules apparently beneath the skin as in Stellaster; aboral plates obscured except on rays where a single median series of squarish or oblong plates extends nearly to tip; the last 3 superomarginals are in contact and separate these radials from the terminal plate; beyond the fifth superomarginals the radial plates are very minute. Single small papulae occur at each corner of the radial plates and of the first 3 superomarginals. A few low, oblong pedicellariae quite small but relatively of large size are scattered on the distal portions of the disk. On each basal radial (or the first carinal) plate is a relatively large bluntly rounded tubercle, higher than thick. Madreporite relatively large, circular, a little more than its own diameter from the interradial superomarginals, in line with, and between, two of the radial tubercles.

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[1] *dubius* = doubtful, in reference to the uncertainty as to whether this probably immature form belongs in this genus.

Superomarginal plates, 12 on each side of each ray, the terminal 3 completely in contact; excepting the last 2, their length and breadth are nearly equal, the height rather less; the twelfth is much shorter than wide while the penultimate is intermediate between it and the tenth; the first is much wider on the inner margin than on the outer; the skin which covers the aboral plates seems to extend over the superomarginals and a few scattered, very minute granules may be seen with a lens, but there are no spines or tubercles. Terminal plate relatively very large, 1.5 mm. long, 1 mm. wide at base, narrower at tip where it carries 4 horizontally projecting short, thick spinelets, 2 from the upper margin and one from each lateral margin.

Actinal interradial areas with 12–14 well defined plates, arranged thus: a very small unpaired triangular plate close to the oral plates; distal to this a pair of relatively large, irregularly hexagonal plates, wider than long; next a transverse series of 3 plates much wider than long, and then 2 plates much wider than long, adjoining each of the interradial pair of inferomarginals; laterally distal to these on each side, in contact with either the first or second inferomarginal or both, is a much smaller elongated plate, and beyond this there may be a still more minute plate; all of these actinal plates carry more or less scattered minute granules, and the larger ones also bear an incipient pedicellaria or a conspicuously larger granule; the largest plates may carry both a pedicellaria and a granule.

Inferomarginals correspond exactly in number, size and position with the superomarginals; they are quite smooth and carry no spines or spinelets; on the distal margin of some of the distal plates, one or two minute granules may be detected. Adambulacral plates more than 30 on each side; the proximal ones are large, about as long as wide, with a marginal series of 5 subequal, flattened, round-tipped spines; distally the plates become very small and the number of spines reduced to 2 or, at last, to 1; on the surface of the proximal adambulacrals there is a series of 3 or 4 minute granules forming a distinct line parallel to the margin, but distally this line is gradually reduced to 2 granules and ultimately to 1 or none. Oral plates conspicuously swollen; each has a marginal series of 5 or 6 relatively large spines, the innermost at tip of jaw much the largest, about .75 mm. long; there is a single large granule on the surface of each plate, near center, and there are much smaller granules present, particularly near the median crest of the jaw.

Color of upper surface pale gray; lower surface lighter but not quite white, although under a lens it looks so. My field notes say of the color in life of other specimens: "light olive gray, variegated with darker, the terminal plate and a distinct band on distal half of arm, dark; lower surface pure white except terminal plates which are dark. On preservation grays become browns." The paratypes now range from nearly white to very pale yellowish-brown; there are no markings whatever nor do the terminal plates stand out in any contrast.

Holotype, M. C. Z. no. 3160 from Broome. Gift of Captain Beresford E. Bardwell, June 1932.

There are 4 paratypes dredged in June, 1932 near Broome, considerably smaller than the holotype but agreeing with it in all essentials. The skin of the aboral surface is scarcely indicated so that the outlines of the plates are easily seen, the papulae are more conspicuous, the granules very minute. There are no tubercles on the basal radials but in the 2 larger specimens, the coming development of such tubercles is plainly indicated. The terminal plate has only a single median spine projecting out from the distal end; probably the presence of 2 in the holotype is abnormal. The lower surface is quite free from granules and the number of plates is of course more or less considerably reduced.

In 1929, a very small pentagonal sea-star was dredged in the vicinity of Lagrange Bay, in 5–7 fms., which at the time was quite unidentifiable but which seems to be almost surely a very young specimen of this new species. It is 6 mm. in diameter with $R = 3.5$, $r = 2.5$, more or less. There are about 70 aboral plates, symmetrically arranged, 15 at center, and 10 or more in each radius; 3 or 4 pairs of papulae are also evident in each radius; there are 2 superomarginals present on each side of each ray, the first relatively very large, the second much smaller; a relatively huge terminal plate with 3 projecting spines at the tip, completes each ray. Orally, 30 inferomarginals, 40 adambulacrals, 5 pairs of orals and 10 actinal intermediate plates cover the surface; 2 spines at the tip of each oral plate are disproportionately big, and the same is true of the orals themselves, as well as the interradial inferomarginals. There are no granules on either surface.

This is a very perplexing sea-star and as even the holotype is probably still quite young, its affinities are uncertain. It was at first believed to be simply the juvenal form of *Stellaster incei* but in the large series of that species, taken at Broome and at Lindeman Island, there are a number of young individuals as small as the holotype of the present species and even smaller. Comparison shows at once that they are certainly not identical. The young Stellasters have wider arms, a more arched disk, more numerous and more granular aboral plates, fewer superomarginals, and the inferomarginal spines more or less well developed. Orally however the resemblance is extraordinary but Stellaster has many more granules and more numerous adambulacral and oral spines. The possibility that *dubius* is the young of Ogmaster or Iconaster is promptly negatived by comparison with specimens of those genera. That it is really an Anthenoides seems improbable owing to the long slender arms but the superficial resemblances between these specimens from Broome and young *Anthenoides peircei* Perrier from Barbados are so striking, it cannot be considered improper to let *dubius* remain in the same genus with the West Indian sea-star until more nearly adult material is available.

STELLASTER INCEI

Plate 2, figs. 1–2

GRAY, 1847. Proc. Zool. Soc. London, p. 76.

This is one of the common sea-stars at Broome and 44 specimens lie before me, all but four from 5–8 fms. in the vicinity of Broome and southwestward to Lagrange Bay; the exceptions are 3 specimens from Lindeman Island, Queensland, and a large adult from Augustus Island, sent on by Captain Bardwell. The specimens from Broome undoubtedly fall in the *incei* group, according to the latest revision of Stellaster, a careful study by Döderlein (1935, pp. 86–101). But they show great diversity among themselves in form and spinulation and lead one to doubt very seriously whether the forms to which names are given by the pre-eminent European authority on sea-stars, are really worthy of such recognition. This is not the place to take up the question in detail but some notes on the specimens at hand may be of value.

In size the forty Broome specimens range in length of R from 14 to 72 mm. The form of these two extremes is the same, R = 2.3 r, and this may be considered characteristic of this group of specimens young and old; the extremes of form are R = 2r and R = 2.6r. The smallest specimen has an incipient tubercle on each of the five basal radial plates (i.e. the first plate of the carinal series), and these 5 tubercles are commonly the first to appear and the largest of all, but it is not often that all 5 are present, symmetrically placed and uniformly developed. In some specimens they are wanting, notably in an individual with R = 35 mm., which has no tubercles at all; in this case, the plates which should bear these primary tubercles are easily distinguished and I am unable to satisfy myself that they never bore tubercles; it is not beyond question that these were accidentally knocked off in the dredge, when the specimen was taken, but careful examination of this and other specimens makes me feel this is very unlikely. After R = 40 mm. tubercles develop in more or less considerable numbers and quite irregularly; there is also great diversity in size and sharpness; they rarely exceed 2 mm. in height and may be that much in thickness at base; commonly they are more slender and they are very generally pointed but in some individuals they are quite blunt; the number ranges from a dozen or even fewer to more than 300; while the largest number naturally occurs on the largest specimen there is no close correlation between the number and size — a specimen with R = 55 mm. has only about 45 tubercles and most of these are very small.

An important feature of these Broome Stellasters is the presence, in three of the largest specimens, of spines on the superomarginal plates; in all cases, they are low and pointed and irregularly distributed; in one case they are mostly on the distal plates while in the others they are chiefly in the interradii; in the largest specimen two often occur on a single plate, one near the upper, the other near the lower, margin. As Döderlein considers the absence of spines on the superomarginals one of the main features of the *equestris* group, in which he places *incei*, their occurrence in these Broome specimens is particularly interesting. It leads me to believe that *St. tuberculosus* v. Martens, of which only a single specimen — from an unknown locality — is known (figured by Döderlein), is simply a specimen of *incei*, like these from Broome, with which it agrees in size and form. It is of further interest that the three specimens with superomarginal spines have 2 spines on many of the inferomarginal plates, especially in the interradii, but some large specimens without superomarginal spines show this same peculiarity. In the smallest *incei* from Broome, single inferomarginal spines are just beginning to show on the first pair (interradial) of plates, but are well-developed on the following seven; in all other specimens they are present on all the inferomarginals.

In life *Stellaster incei* is a handsome sea-star but the colors fade rapidly and disappear more or less completely. At Broome the coloration is surprisingly constant in shades, but very diverse in details. Young individuals are light brown above and cream-white below; as they grow, some, and at last many, aboral plates become outlined with dark brown; in some specimens, there is more or less variegation of light and dark brown; as a rule, the larger the specimen, the more conspicuous are the dark shades and markings; some individuals have an olive or gray cast but fundamentally the color is brown. While the specimen is still very small, R = 18 mm., the pair of actinal intermediate plates, right behind the oral plates become dusky purple and soon the color has become deep purple and the dark color has appeared in other plates, particularly in the series adjoining the adambulacral plates. In larger specimens, these colored plates are a deep purple-brown and even the median inferomarginal plates are dusky-purplish. The number of dark actinal intermediate plates in any specimen, and indeed in any area, is subject to great diversity, so that no two specimens in a small lot will be exactly alike; each plate is always either wholly white or wholly dark, but as many as 19 plates in one area may be dark. Very early, an orange spot appears at the base of each interradial, inferomarginal spine; soon the oral spines begin to show orange, and as the animal grows the extent and intensity of the orange increases greatly. The adult *incei* is thus brown above, more or less marked with darker, and white below, with few or many interradial plates dark purplish-brown, and much intense orange on oral, adambulacral and (basally) inferomarginal spines; pedicels, including suckers, white. After drying, specimens become "museum color" but in well preserved individuals, the dark plates of the actinal areas are detectable by their dull brown-orange color, and an orange tint may still be noted in the adambulacral armature.

One of the specimens taken at Broome in 1932 is notable for being symmetrically hexamerous. It is adult with R = 60 mm. and r = 30. On one ray, at the distal end of the ninth superomarginal on the left hand side (seen from above), there is an incipient secondary arm, as though the ray would fork at that point; the new ray has 3 superomarginals on each side, but those of the inner side are very small as is the terminal plate; there are two inferomarginal plates, one on each side; the ambulacral furrow does not divide to enter the new arm. On two other rays, at the distal end of the eleventh superomarginal, there is a distinct indication of similar abnormal growth but actual development of additional superomarginals has not occurred.

The specimen taken by Captain Bardwell at Augustus Island differs obviously from specimens of like size from Broome in the much longer arms, for R nearly equals 3r. It thus resembles very closely the form which Döderlein figures (1935, p. 99, pl. XXVI, figs. 2, 2a) as *S. equestris* forma *gracilis*, originally named by Möbius as *St. gracilis* and based on a specimen from China. But I fail to detect any other character, save arm-length, by which it can be distinguished from the Broome material, and as it seems to have had the same coloration judging from the present appearance, particularly of the actinal intermediate areas, it seems only reasonable to consider it a very long-armed *incei.*

This decision is confirmed by one of the 3 specimens which Mr. Ward has sent from Lindeman Island. This individual has R = 68 mm., r = 24 mm.; hence R = 2.8r ±. The actinal surface shows 36 of the orange-brown plates characteristic of *incei.* In practically every detail this specimen is identical with the one from Augustus Island.

The other 3 specimens from Lindeman Island are very young, the smallest Stellasters I have ever seen. In the smaller R = 9 and r = 4 mm., hence R = 2.25r. There are 6 superomarginal plates on each side of each ray and an incipient seventh adjoins the terminal plate in each series. The 5 primary radial tubercles are visible but very low. There are 7 inferomarginal plates in each series; most of them show no trace of an inferomarginal spine but on 1, 2 or 3 plates in each series a minute spine is present near the distal margin of the plate. The other specimen has R = 10.5 and r = 4.5 mm., hence R = 2.33r. There are 7 superomarginal plates on each side but the seventh is distinctly smaller than any others. The 5 primary radial tubercles are barely evident. There are 7 inferomarginal plates in each series; the first are much the largest and have no marginal spines but most of the succeeding plates have the spine on the distal margin distinctly developed.

STELLASTER INSPINOSUS

Plate 3, figs. 1–2

H. L. CLARK, 1916. "Endeavour" Rep., p. 48.

This is the characteristic Stellaster of the western coast of Australia and is common near Fremantle. We dredged many specimens between that port and Garden Island in 2–3 fms. Their striking and constant coloration, so different from that of *incei,* was obvious evidence that they were not that species but the presence of at least a few inferomarginal spines in most of the specimens led me to suppose they might not be *inspinosus.* Examination however of the 34 specimens at hand, all adult with R = 70–90 mm., and comparison with a cotype of *inspinosus,* shows plainly that all are representatives of that species. It is a little strange that no young or half-grown specimens were secured, for scores of specimens were dredged.

Misled by my careless failure to refer to the convex disk plates, and by the presence of inferomarginal spines in his specimens, Döderlein (1935, p. 89) has described and figured this species under the name *St. gibbosus.* He published a very brief and hardly descriptive reference to *gibbosus* in October, 1916, but as my account with figures was published June 2, 1916, there seems to be no doubt that the less accurate name survives; the aboral plates are more or less gibbous but the inferomarginals are usually not entirely lacking in spines though these are commonly small, and poorly and irregularly developed.

The coloration in life seems to be very constant but unfortunately disappears more rapidly and even more completely after preservation than does that of *incei.* The upper surface of the living sea-star is a dull brick red while the lower surface is a reddish white with a variable number of actinal intermediate plates deep red, nearly claret, and the inferomarginals, brown with a claret cast; adambulacral and oral plates and spines, yellowish, sometimes almost orange, but pedicels pure white. The series of actinal plates adjoining the adambulacrals is quite uniformly red and in many cases, most, or possibly all, of the other actinal plates are also red; this is particularly likely to be true of large individuals.

The largest of the present series has R = 87–90 mm. and is completely hexamerous; it is fairly but not entirely symmetrical, some of the rays being longer than the others; as three are broken at the tip, it is impossible to determine what their lengths in life may have been.

STELLASTER PRINCEPS

Plate **4**, figs. 1–2

SLADEN, 1889. "Challenger" Ast., p. 323.

It was a great surprise and pleasure to find this magnificent sea-star present at Broome, where we secured a number in 1929, of which 6 are at hand, and 17 in 1932. Several were brought up by pearl-shell divers, or by our own divers (in 1932), but most of the specimens were dredged in 5–11 fms. between Roebuck and Lagrange Bays.

After its discovery by the "Challenger" near Booby Island in Torres Strait and Sladen's description in 1889, this Stellaster lay almost forgotten until Livingstone's discovery of a specimen from "Western Australia" in the Australian Museum. His description and figures (1932) threw valuable additional light on its characteristic features, but he most magnanimously and unselfishly made no reference to the fact that he was present and enjoyed the experience of the rediscovery of the species at Broome in August, 1929.

That I described (1914) a specimen from Port Hedland, W. A., belonging to the Western Australian Museum, as a new species under the name of *Stellaster megaloprepes*, reflects no credit on my perspicacity and I am quite unable to account for my making no reference to *princeps* at that time. It was not until I saw the type of *megaloprepes* again in 1929 at Perth, after having handled *princeps* at Broome, that I recognized the identity of the two. Curiously enough, in his recent admirable revision of Stellaster, Döderlein (1935) has completely ignored my species, which is just as well, as it has no validity whatever.

Sladen, Livingstone and I (in the description of *megaloprepes*) have given so many details as to structural features and spinulation as to make any detailed discussion of them here quite unnecessary but it will be of interest to tell something of the diversity shown by the fine series of 23 specimens at hand. They range in size from R = 63 to R = 150 mm., the last very much the largest Stellaster ever recorded; there are several others nearly as large. The form does not show great diversity but there is some difference in the relative length of the rays; as a rule R = 3r and 3br, more or less, but in very large specimens it is nearer 2.6r. In life the disk is high, the vertical diameter about one fourth R; in preserved specimens, the height depends very largely on the rapidity with which the specimens are killed and preserved; the longer the process, the flatter the specimen, as a rule.

There is great diversity in the spinulation. In the smallest specimen (R = 63 mm.), the 5 primary tubercles on the basal radial plates are very conspicuous, 4 mm. high, 2 mm. thick at base but sharply pointed; on the disk there are about 30 very much smaller spines and on the basal part of each ray (less than the basal half) there are 3–5 carinal, conical tubercles, not quite 2 mm. high, and about 20 very much smaller tubercles irregularly placed but tending to form 2 series on each side of the carinal row. There are no spines or tubercles on the superomarginals. The inferomarginal plates each bear 2 spines, the upper and inner, much the larger, about 4 mm. long; the distal half dozen plates bear only one spine each. Adambulacral plates (near mouth) have 6 rather slender furrow spines, and 2 large, flattened spines on the surface; of these the adoral is more than 2 mm. high and its breadth is fully half as much; the distal spine is much smaller. There are many relatively large pedicellariae on the actinal intermediate plates, especially on the series adjoining the adambulacrals. Oral plates, with 7 marginal spines, innermost largest, compressed, rounded at tip, outermost small and pointed; on surface of each plate near the proximal end is a very large flat spine (somewhat larger than on the adambulacrals) set transversely across the plate.

As growth proceeds the number of aboral tubercles increases both relatively and actually but there is considerable diversity in their size, form and distribution; in some cases they are short and thick, with blunt tips, in others they are much more spiniform with very sharp tips; in some individuals the carinal series does not extend outward beyond the base of the arm, and may be very incomplete even there; usually it runs out about half the length and occasionally it extends clearly almost to the arm-tip. The 5 primary radial tubercles generally lose their preëminence as growth proceeds and in adult specimens can be made out only with careful examination; occasionally however they continue larger and more conspicuous than their fellows. In the largest specimen, there are more than 600 tubercles on the aboral plates and even on the interradial superomarginals small pointed tubercles occur; these are chiefly single at the upper end of a plate, but occasionally are near the lower end; now and then two occur on the same plate and on one first superomarginal there are 3 tubercles in a vertical series. Tubercles on the superomarginals are however quite unusual and occur only in the largest specimens. Livingstone (1932) has pointed out how numerous the inferomarginal spines become (5–7 on a plate) and how they are arranged, in the interradii, in two diagonal series, all of which is well exemplified in the big specimen in hand; the largest inferomarginal spines are 8 mm. long by 2.5 mm. wide. Sladen's (1889) description of the adambulacral and oral plates and the actinal intermediate areas fits the present specimens very well, but the big adambulacral spines are fully 6 mm. long.

The coloration of *princeps* in life is one of its most characteristic features. The upper surface is olive-gray with dark gray or dark brown (almost black) markings; particularly conspicuous are a group of irregular spots distal to the middle of each arm, and scattered spots on the disk; the lightness or darkness of the ground color shows some individual diversity and the markings of course are not exactly alike in any two specimens; as a rule, the larger specimens are darker and more spotted or marked. The oral surface is a clear ivory white, while a circular area, of which the mouth is the center, is a bright violet or purple; the pedicels are pure white in contrast to the ivory-white of the adambulacral armature. The diameter of the purple area shows some diversity but its circular form is constant and there is no tendency for the interradial areas as a whole to be purple. Unfortunately the colors are very fugacious; soon after death olive-gray becomes brown and begins to fade, so that in a few hours the characteristic color is gone. In dry specimens the purple color persists for several weeks but it ultimately disappears completely. Dry specimens at the present time are more or less uniformly "museum-color." In most of the larger specimens the disk both above and below is discolored probably from the oily secretion of the hepatic organs. In some individuals, especially the younger ones, the dark markings on the rays persist in an orange-brown shade.

ASTERODISCUS TRUNCATUS

COLEMAN, 1911. Mem. Austral. Mus., **4**, p. 699.

A single small specimen (R = 70 mm.) of this interesting sea-star was taken by Mr. D. L. Serventy in a productive dredge-haul, Feb. 23, 1930, by the trawler "Bonthorpe," in 90 fms. at the western end of the Great Australian Bight, 33° 15′S x 126°22′15″E. It was presented to me by Professor Bennett. Although the aboral surface is badly rubbed by the rough handling in the dredge, the specimen is particularly interesting as the smallest individual of the species yet taken. Unfortunately there are no data as to the color in life; the dry specimen is light gray, somewhat darker aborally.

Notes on the Subfamily **ANTHENEINAE**

Among the most conspicuous and generally common sea-stars of tropical Australia are the members of this subfamily, and the diversity of their color and size is so bewildering that the division into well-defined genera and species is a most perplexing task. The great German zoölogist, Döderlein, brought order out of what was almost chaos when he published (1915) his revision of the genus Anthenea, but the large amount of material collected in 1929 and 1932 and the considerable series in the Australian Museum[1] necessitate a new attack on the problem. The arrangement and keys here offered are of course based on Döderlein's work and it is hoped may prove as useful, but there is no expectation that they are complete or in any way the "last word" on the subject. In the end, some Australian zoölogist must be the authority, who, through the advantage of large numbers of living specimens from various points on the tropical and subtropical coasts of that continent, may find the key to the real inter-relationships of these fascinating sea-stars. Without any pretence of delimiting the subfamily, the following 5 genera are here discussed.

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[1] The entire lot was most generously sent to me in Cambridge so that I could compare them with our collection. There have thus been available to me 249 specimens of Anthenea and its nearest allies.

Key to the Genera of Antheneinae

A. Dorsal surface and marginal plates covered with a closely crowded coat of flat-topped polygonal granules; some (often many) abactinal plates carry a large smooth tubercle, often with one or two smaller tubercles adjoining it closely or it may be replaced by 3–7 similar but smaller and closely crowded tubercles........................*Anthaster*

A¹. Dorsal surface not as above.

- B. Superomarginal plates of interbrachial arcs with 1–3 (usually 3) spines on the outer margin; many actinal intermediate plates with a tuft of spines instead of the usual pedicellaria; only 3 adambulacral spines in the furrow series........*Pseudanthenea*
- B¹. Superomarginal plates with granules or tubercles or both, but no spines; no spines on actinal intermediate plates; more than 3 adambulacral spines in furrow series.
  - C. Only 2 series of adambulacral spines, outer end of adambulacral plates being bare and smooth (except on distal third of arm in some Pseudoreasters).
    - Some aboral plates, often many, particularly in the carinal series with big hemispherical tubercles, 2–6 mm. in diameter; superomarginal plates more or less vertical, with numerous coarse granules, the upper end not forming a conspicuous part of the aboral surface of the sea-star.....*Pseudoreaster*
    - Tubercles on aboral surface much less conspicuous, usually not 2 mm. in diameter; superomarginal plates with upper half bare and smooth, forming a marginal border for aboral surface, with a few (often only 2 or 3) small tubercles or coarse granules on the lower half.............*Gymnanthenea*
  - C¹. Adambulacral spines in at least 3 series........................*Anthenea*

ANTHASTER

This well-marked genus was established by Döderlein for the following species and, as yet, no other is known.

ANTHASTER VALVULATUS

Oreaster valvulatus MÜLLER and TROSCHEL, 1843. Arch. f. Naturg. **9** (1), p. 115.
Anthaster valvulatus DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. (27) 30.

When Döderlein established his new genus, only a single specimen of this interesting sea-star was known — the original type on which Müller and Troschel based the species, but a few years ago (H. L. Clark, 1928) it was learned that on the coast of southern Australia, Anthaster is by no means rare. Now it appears that it ranges around the southwestern corner of the continent and as far north at least as Cottesloe, for there are 3 specimens at hand, loaned by the Perth Museum, 1 from Long Reach Bay, Rottnest Island, and 2 from North Beach, near Cottesloe. Apparently the species is not common and lives in moderately deep water. The specimens from North Beach are in poor condition and were apparently from beach "wrack," but the one from Rottnest is in excellent condition and bears a label saying that the "colour" (presumably in life) was "brick-red."

PSEUDANTHENEA

This genus was also established by Döderlein for a single species:

PSEUDANTHENEA GRAYI

Anthenea grayi PERRIER, 1876. Arch. Zool. Exp., **5**, p. 94.
Pseudanthenea grayi DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. 26.

Perrier based his species on a single specimen in the British Museum from an unknown locality. Apparently it has never been met with since.

PSEUDOREASTER

This genus was proposed by Verrill for the following species but has received scant attention. Its validity having been called in question by Döderlein (1915, p. 49) even after some of its characters had been pointed out by Fisher (1911, p. 174), the availability of a large number of specimens, showing great diversity in size and tuberculation, has led to a careful reëxamination of its status, which results in the belief that it is fairly entitled to recognition. No second species has as yet been found but it is not at all unlikely that it may be discovered in the marvellous marine life of the northwestern coast of Australia.

Attention should be called here to the curious slip of the pen by which Döderlein (1915, p. 49) gives "Protoreaster" as Verrill's name for this genus. As he had correctly quoted both Verrill and Fisher on the preceding page, and as he subsequently (1916, p. 420) establishes a genus Protoreaster for *Oreaster nodosus* (L.) and two closely allied species of that genus, without any reference to his use of the name the previous year, it is obvious that the latter is simply a *lapsus calami* to which his attention was never called. It cannot therefore invalidate in any way his later use of the name.

PSEUDOREASTER OBTUSANGULUS

Plate 6

Asterias obtusangula LAMARCK, 1816. Anim. s. Vert., **2**, p. 556.
Pseudoreaster obtusangulus VERRILL, 1899. Trans. Conn. Acad., **10**, p. 148.

This is one of the commonest and most characteristic sea-stars of the northwestern coast of Australia from Port Hedland (where Michaelsen and Hartmeyer procured their only specimens; see Döderlein, 1915, p. 49) northeastward to Augustus Island, at least. There is only a single specimen in the Australian Museum and that is from the "coast south of Broome." Apparently no specimens are in the Western Australian Museum. It is not unreasonable to suppose therefore that the genus is confined to the strictly northern coast of Western Australia. The present series consists of 26 specimens — 4 adults from Augustus Island (B. E. Bardwell leg., October, 1933), 8 adult and young from False Cape Bossut (September, 1929), and 13 adult and young from the Broome region (September, 1929 and June, 1932), plus the small adult belonging to the Australian Museum, already mentioned.

The smallest specimen has R = 42 mm., r = 20, while the largest has R = 115 mm., r = 56; this ratio of R = 2r seems to be remarkably constant regardless of size or locality. The aboral surface is elevated so that the form is more like Oreaster than in any species of Anthenea. The vertical diameter in life may be .40R and even in some dried specimens it is .33R; most individuals however become nearly flat when dried. The diversity in tuberculation of the aboral surface is very great. The young individuals have the big tubercles scarcely 2 mm. in diameter and they occur only on the carinal series of plates; occasionally this condition persists into adult life (thus a specimen with R = 80 mm. has but 3 tubercles, exceeding 3 mm. in diameter, one at the left hand side of the tip of one ray and 2 at the right hand side of the distal half of another ray) but usually the big tubercles are fairly numerous, though very irregular in distribution, in specimens with R = 50 mm. or more; an extreme case is an individual with R = 70 mm., which has 83 big tubercles distributed thus: 18 on one ray (3 on distal superomarginal plates), 14 on the next ray, 20 on the next (2 on distal superomarginals), 13 on the next (2 on distal superomarginals) and 18 on the next (1 on a distal superomarginal). The occurrence of the big tubercles on the superomarginals is by no means uncommon but it is not characteristic. More common is the reverse condition where the coarse granulation of the superomarginal plates is repeated on some of the distal aboral plates, replacing the big tubercles. Indications of this occur in the great majority of adults but the extreme case is a specimen with R = 76 mm. in which the big tubercles are confined to the carinal series and only those tubercles nearest the disk exceed 3 mm. in diameter; but there are 77 aboral plates on the distal portion of the rays which bear clusters of coarse tubercles similar to those on the superomarginals. The oral surface shows little change in growth from the smallest to the largest specimen and there is surprisingly little individual diversity.

The color in life is often bright red, with the superomarginal granules distally, black, and the big tubercles brown or red. Some specimens are not so bright colored, and my field notes, from which the following items are quoted, show that there is a great deal of diversity: "As a rule the color was varied and variegated with dull grays, brown, reds and purples." "In color, no two are alike; all are variegated with browns, ranging from deep red-brown to brown-orange; often interbrachial areas have large blotches of a very dark color; orally cream-color with interradial areas, at least the inferomarginals, red, orange, brown or dull red violet, more or less." "The handsomest specimen is grayish with much red of several shades, especially large red blotches in interbrachial areas." Another was "mottled browns and greens, rather dark." The bright colors fade quickly after death particularly if the specimen is dried. The reds become more and more orange and often disappear entirely but most dry specimens retain more or less of the orange tint and a few are distinctly light dull reddish.

GYMNANTHENEA[1] gen. nov.

Genotype, *Anthenea globigera* Döderlein, 1915. Jahrb. Nassau. Ver. Naturk, Wiesbaden, **68**, p. (29), 50.

Although Döderlein seems to consider his *globigera* rather close to *australiae*, owing to the bare upper ends of the superomarginal plates, it is really quite well set apart from that species and other Antheneas by its adambulacral armature which, as Döderlein points out, is much like that of Pseudoreaster. Indeed the oral aspect of Gymnanthenea is rather markedly like that of this otherwise quite different genus. As a second species, closely allied to *globigera*, occurs at the Abrolhos Islands, it seems best to place them in a genus by themselves, hence the formation of Gymnanthenea.

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[1] γυμνός = *naked* + Anthenea, in reference to the bare aboral surface of the superomarginal plates.

Key to the Species of Gymnanthenea

Dorsal tubercles more or less numerous; dorsal pedicellariae few, small, inconspicuous; dorsal surface covered with a thin skin . . . . *globigera*

Few or no dorsal tubercles; large pedicellariae conspicuous on aboral plates, especially on adradial series; 2–5 tubercles but no pedicellariae on superomarginal plates; dorsal surface covered with a thick, dark skin . . . . *laevis*

GYMNANTHENEA GLOBIGERA

Plate **11**, fig. 2

Anthenea globigera DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. (29), 50.

This species was based on a single specimen from Turtle Island, Northwestern Australia, collected by Michaelsen and Hartmeyer. It proves to be one of the commonest sea-stars in the vicinity of Broome, especially in shallow water along shore. Young individuals occur frequently under rocks in tide pools while the larger specimens are common in water 1–5 fms. deep. It is a well-characterized form and shows comparatively little diversity. The series at hand ranges from $R = 6.5$ mm., $r = 3.5$ mm., to $R = 85$ mm., $r = 40$ mm.; hence $R = 2r$ in all except the very youngest individuals. In the youngest, there are no tubercles at all and the superomarginal plates have only very fine granules, but in a specimen with $R = 12$ mm., the 5 basal radial tubercles are evident; when $R = 20$ a number of additional tubercles are present in the carinal series on each ray; a small tubercle and coarse granules are present on each superomarginal, on the outer side; the upper surface, like that of most of the aboral plates, is relatively smooth and flat. With increased growth, the number of tubercles and granules increases, until the adult condition is reached when most of the dorsal surface, excepting on the distal part of the rays, is well covered with tubercles, granules and small pedicellariae; in typical specimens, the distalmost radial plates and the last 6–8 adradial plates on each side are quite bare but have a fine shagreen-like surface; the upper side of the distalmost superomarginals may have a similar surface.

In life, young specimens are cream-color or pinkish-white, with marginal plates distally pink; then dark mottlings appear on the rays and by the time R = 30–40 mm. great diversity of color is evident. Individuals are often bright orange-red, but owing to the fact that the lines between the different species of Anthenea were very vague in my mind during the field work and the number of specimens taken was too great to permit of each one being properly noted as to color and other characters, it is impossible now to say whether any particular colors or shades are associated in any characteristic way with this species. To the best of my recollection orange, pink and red shades were common and in adults merged with browns and grays, in bewildering dissimilarity. The dry specimens are for the most part more or less "museum color" but some individuals give distinct indications of having been variegated with orange or red; the disk is often darker than the distal part of the arms.

The 55 available specimens of *globigera* are from the following localities:

"North Australia": 1 specimen with R = 59 mm., identified by me (1928, p. 384) as "*Anthenea flavescens.*" This specimen has nothing to do with *flavescens* but is undoubtedly *globigera* and raises the question as to where on the coast of the Northern Territory this specimen was taken. Loaned by the South Australian Museum.

"Northern Territory": 1 young specimen dry and broken, also loaned by the South Australian Museum. Here again it would be very interesting to know just where on the coast of the Northern Territory this specimen was taken. The identification admits of no question.

Port Darwin. Messrs. Christy and Godfrey leg. et don. 1 specimen, adult in excellent condition but bleached to a uniform brownish cream-color. Not typical, for the granules on the superomarginal plates are smaller and somewhat more numerous than they should be, and the outer series of the adambulacral armature usually contains 3 and sometimes 4 spines. It is not rare to find 3 spines in a series on Broome specimens but in no case is the number frequent, and 4 have not been found on a single plate. Loaned by the Australian Museum. (G 3813).

Port Darwin, 1935. 1 specimen, young (R = 48 mm.). Loaned by the Australian Museum. (J 5894).

Western Australia: Augustus Island, October 1933. Capt. Beresford E. Bardwell leg. 8 typical specimens, small adults, and young.

Broome, August and September, 1929. 21 specimens, adult and young, but mostly young ones taken in tide pools or near jetty.

Broome, June 1932. 20 specimens, adult and young, but mostly adults dredged in Roebuck Bay and southwestward.

False Cape Bossut, September, 1929. 1 adult.

"Estuary of Swan River, near Fremantle." 1 small adult, with exceptionally thick skin, loaned by the Australian Museum. The locality seems to me highly improbable.

GYMNANTHENEA LAEVIS[1] sp. nov.

Plate 19, figs. 4, 5

Rays 5. R = 70 mm., r = 34 mm. R = 2r. Upper surface elevated, particularly on the basal portion of each ray where the vertical diameter is fully 20 mm. whereas the distal part of the ray is flattened and only 9–10 mm. thick. Upper surface covered with a smooth, thick skin, in which the large groups of papulae are evident and the big pedicellariae are conspicuous. Tubercles wholly wanting, except near the base of each ray, where the first of the carinal plates carries an obvious tubercle about a millimeter in diameter but scarcely a millimeter high; proximal or distal to this there is usually a smaller tubercle and similar small tubercles may occur on one or both sides; althogether about 15 of these small tubercles can be made out with a lens. Pedicellariae, low, horizontal, with jaws 1–3 mm. long; as they are nearly white in contrast to the skin, they are very conspicuous; there are 15–20 on the basal portion of each ray but confined to the disk; while often on the adradial series of plates, they are more usually on the adjoining series, and a few are even further from the carinal plates.

Superomarginals form a conspicuous, smooth margin to disk and rays. The first ones are nearly 5 mm. wide by 4 mm. long but little more than 2 mm. high; on the vertical surface are 2 (or 3) tubercles, about a millimeter in diameter, conspicuous because of their light color, and below them are a very few small granules. Distally the plates are somewhat smaller, but even the twelfth, at the tip of the ray, is fully 2 mm. square and the pair of marginal tubercles is evident; granules do not occur beyond the fourth plate. Madreporite 5 mm. long by 4 wide, only 7 mm. from center of disk.

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[1] *laevis* = smooth, in reference to the thick smooth skin and absence of tubercles.

Oral surface with large, skin-covered actinal interradial areas, the outlines of the plates obscured by the skin but each plate conspicuously indicated by its large pedicellaria, or a group of granules or both. Inferomarginal plates large and conspicuous, the middle pair, 5 mm. wide and 3.5 mm. long; they correspond well in number and position with the superomarginals, but at the tip of the arm, adjoining the very small terminal plate, an extra inferomarginal is intercalated. First inferomarginals bear 15–20 (or more) tubercles and a big pedicellaria conspicuous because of their light color; the pedicellaria lies across the plate and the larger tubercles are between it and the superomarginal; at the extreme outer end of the plate are some small granules; the largest tubercles are smaller than those on the superomarginal; on succeeding inferomarginals the armature is similar, but there are often two pedicellariae; distally the granules disappear, and the number of tubercles falls to 9, 4, 3, 2 and 1 on the distalmost plates.

The series of actinal plates adjoining the adambulacrals extends out to the twelfth inferomarginal; the first two or three each carry a huge pedicellaria with or without one or two tubercles; distally the number of tubercles increases to 3 or 4 and the pedicellaria decreases in size; rarely a plate lacks a pedicellaria. The next series of actinal plates extends to the eighth inferomarginal and consists of about 15 plates; the first one is like the first ones in the adjoining series wholly occupied by the huge pedicellaria but on subsequent plates the tubercles are more numerous and the pedicellaria is more often wanting; the remaining plates of the actinal intermediate areas, 35–40 in number, usually each carry a large pedicellaria and half a dozen small tubercles but not rarely the pedicellaria is wanting, especially on the smaller plates.

Adambulacral armature very simple, in two series; a marginal or furrow series of half a dozen rather slender spines, the median ones longest, the outermost on each side smallest; on the surface of each plate close to the furrow series are two (sometimes 3 near base of arm) subequal, stout spines, side by side, expanded and rounded at tip; outer half of plate perfectly bare. Oral plates small, each armatured by marginal and surface spines like two adambulacral plates; marginal spinelets at apex of jaw relatively large and conspicuous, but the most proximal of the surface quartet is the smallest while the distalmost is the largest spinelet on the whole oral surface.

Color of dry specimen, aborally, purplish-brown with tubercles and pedicellariae whitish in more or less marked contrast; madreporite brown; orally, wood-brown with tubercles, spinelets and pedicellariae conspicuously lighter.

Holotype, M. C. Z. no. 2772, from Western Australia, Abrolhos Islands, "Wallaby Group, shore collecting." Percy Sladen Expedition. W. J. Dakin leg. et don.

This specimen was identified by me (1923, p. 239) as *Anthenea globigera* Döderlein, but now that a large series of that species is available for study, it seems best to give this very exceptional specimen specific rank. Only further collecting at the Abrolhos can demonstrate the propriety of such action.

ANTHENEA

Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 279.

Genotype, *Anthenea chinensis* Gray, 1840, l.c. = *Asterias pentagonula* Lamarck, 1816, Anim. s. Vert., **2**, p. 554.

Since the majority of the species of this fine genus occur on the Australian coast it has seemed desirable to prepare a key to all the known species.[1] Döderlein (1915) did this admirably but the large collections of Australian material available to me have led me to somewhat different conclusions in regard to the status and relationships of some of the species, and it seems best to state them here. The elimination of Pseudoreaster and Gymnanthenea leaves Anthenea a more homogeneous group. The species are seldom sharply defined but it is hoped that the following key will prove as useful to future workers as Döderlein's has been to me. I am recognizing as valid, 19 species and 1 variety of which 14 species occur on the coasts of Australia, chiefly in the tropics.

Key to the Species of Anthenea

N.B. Owing to the great diversity in body form shown by the more common species of Anthenea due in part to differences in age, size and environmental conditions, and in part to methods of preparation and the care used therein, it must not be expected that this key will prove a satisfactory guide in every instance. Similar diversity in number, size and form of spines, tubercles, granules and pedicellariae will also give much trouble but it is hoped, nevertheless, that normal, adult specimens can be satisfactorily traced to the proper species. Senescent specimens of *acuta* are very perplexing, and of course, young individuals of any species with R = 35 mm. or less, will always give difficulty. It is doubtful whether such young individuals can be identified correctly without comparison with considerable series of specimens.

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[1] I have not included *Anthenea mexicana* A. H. Clark (1916), as the single specimen on which it is based is only a half grown individual without distinctive characters and said to be from Mexico, a locality which certainly requires confirmation.

A. Arms relatively long, R = 2r, more or less (1.90–2.45 r in most cases, but in some senescent specimens only 1.5 r), narrowed distally, and commonly more or less pointed (at one-tenth R from tip, width is about .15 R or even less but may be .18–.20).

B. Each of the 5 basal radial plates with a conspicuous pointed tubercle; many distal superomarginals and some inferomarginals bear a spine-like pointed tubercle. . . *rudis*

B¹. Not as above.

C. Pedicellariae extraordinarily abundant on oral surface, many of small size; inferomarginals with 6–15 or even more; actinal intermediate plates with the usual pedicellaria, often accompanied by 2 or 3 smaller ones. *polygnatha*

C¹. Pedicellariae not excessively abundant, orally, rarely more than 3 or 4 on an inferomarginal plate.

D. Disk elevated, covered with a smooth, thin skin, with few pedicellariae or small spinelets; big blunt spinelets on many aboral plates; superomarginals interradially low and wide with few (1–8) granules, but distally higher than wide, with more granules. . . . . *obesa*

D¹. Not as above.

E. Superomarginal plates in interbrachial arc more or less horizontal forming a conspicuous part of the aboral surface.

F. Aboral plates and inner portion of superomarginals bare.
All adradial plates with pedicellariae. . . . . *flavescens*
Only a few adradial plates with pedicellariae. . . . . *flavescens* var. *nuda*

F¹. Aboral plates more or less covered with spinelets, tubercles and pedicellariae; superomarginals (at least the lower half) well covered with granules.

G. Aboral surface with numerous bluntly pointed tubercles, forming 5–9 distinct longitudinal series on each ray; inferomarginal plates closely covered with small granules, and only a single small pedicellaria (2 mm. ±) or often none. . . . . *elegans*

G¹. Aboral surface diverse; inferomarginals with coarse granules, at least at outer end and usually 2 or more large pedicellariae.

Aboral tubercles numerous and coarse; upper half of superomarginals bare on each side with a few coarse granules, often in a narrow, or even a single, vertical series. . . . . *crassa*

Aboral tubercles few, scattered, relatively insignificant; superomarginals rather uniformly covered with granules though they may be fewer and coarser at upper end (See also *pentagonula*). . . . . *aspera*

E¹. Superomarginal plates in interbrachial arc more or less vertical or so small they form an inconspicuous part of the aboral surface. (See also *elegans*).

H. Pedicellariae very large both aborally (with jaws up to 1.7 mm. wide) and orally (with jaws up to 4 mm. wide), and correspondingly conspicuous. . . . . *crudelis*

H¹. Pedicellariae numerous but not exceptionally large.

J. Disk more or less conspicuously elevated, the reticulate nature of its skeleton often distinctly evident in big specimens; superomarginal plates well covered with granules to upper margin. . . . . *acuta*

J¹. Disk usually not much elevated, or reticulated; upper end of superomarginals more or less bare.

Superomarginals low, wide, with tubercles only on lower half; aboral tubercles low and more or less flattened. . . . . *australiae*

Superomarginals high, narrow, with a large granule near top; below it a swollen pair or trio and the rest of the plate (lower half) more or less covered with smaller, but often coarse, granules; aboral tubercles high, not flattened (See also *sibogae*). . . . . *conjungens*

A¹. Arms short and rounded at tip, form often quite pentagonal; R = 1.6–1.8r; at one-tenth R from tip, width is .20 R or more.

K. Aboral plates near arm-tips not much enlarged or conspicuous; aboral surface with few (or more numerous) tubercles or large spinelets, but commonly with very numerous pedicellariae and small spinelets, (specimens with R = 65 mm. or less may have quite smooth aboral plates and few pedicellariae).

Aboral tubercles few, irregularly scattered, seldom capitate; superomarginal plates with coarse granules, often only a few on inner end, the coarsest at outer; coarsest granules of inferomarginal plates also at outer end; rays often somewhat pointed. *pentagonula*

Aboral tubercles more or less numerous, especially on rays, somewhat capitate; marginal plates rather uniformly covered by a coat of small granules; rays wide and rounded. . . . . *regalis*

K¹. Aboral plates near arm-tips enlarged and more or less conspicuous; aboral surface usually with more or less numerous tubercles. (See also *regalis*).

L. Enlarged aboral plates near arm-tips, each with several (2–8) large granules or small tubercles.

M. Whole aboral surface covered with big pointed tubercles, 9–13 series on each ray. . . . . *acanthodes*

M¹. Aboral surface with relatively small, blunt or capitate tubercles.

O. Aboral tubercles numerous, small, in about 9 parallel series on each ray. . . *godeffroyi*

O¹. Aboral tubercles fewer, larger, in not more than 5 series on each ray.

Dorsal surface with few, small spinelets but many pedicellariae. . . . . *sibogae*

Dorsal surface with numerous more or less capitate spines and few pedicellariae. . . . . *mertoni*

L¹. Enlarged aboral plates near arm-tips, each with 1 large granule or tubercle (sometimes 2).

Tubercles of aboral surface and of superomarginals few and coarse. . . . *tuberculosa*

Tubercles of aboral surface and of superomarginals, small, more like large granules. . . . . *viguieri*

Although I have included in the above key, these 20 nominal forms, it is my candid opinion that several are not valid. I have no confidence in either *flavescens* or its variety *nuda* and believe they are based on young, probably unidentifiable, specimens of some of the other species[1], but as I cannot prove this, it is necessary to leave them in the key. The species *acanthodes, crudelis* and *godeffroyi* are each based on a single specimen and are open to question on the grounds of hybridity or extreme individual diversity. They can only be accepted as valid when more specimens are found. The species *crassa* and *aspera* occur at Port Curtis together and it is possible they represent the two extremes of a very variable species. On the other hand, connecting links may be considered as hybrids. Only further collecting at Port Curtis and observations on the living animals can clear up the possible doubt. The group of Antheneas with short, wide, rounded arms, having enlarged tuberculated aboral plates near the tip, is a puzzling one and only much more material can decide whether there is more than one species. As the oldest name, *tuberculosa* will stand, but I am very dubious whether *mertoni* and *viguieri* can be maintained. The probability of *sibogae* being valid is better, but as stated above *godeffroyi* rests on a single specimen and may prove to be only a variant, and *acanthodes* may be a hybrid! The two species *pentagonula* and *regalis* are not very clearly separable and may possibly be identical.

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[1] Possibly *Gymnanthenea globifera* (Död.)

Laying aside these doubts for the present, except for *flavescens* and *nuda*, the 18 species of Anthenea show the following distribution. On the southeastern coast of Asia and perhaps in the northern East Indies is *pentagonula*, the genotype. To the west are found *rudis*, from the Mergui Archipelago to the Persian Gulf, and *regalis*, coasts of India and Ceylon. In the southern East Indies and on the coast of northern Australia occur *sibogae* and its near relatives *mertoni, tuberculosa* and *viguieri*. (The related *godeffroyi* is also supposed to be Australian). To the southeast are found *aspera, crassa* and *acanthodes* on the coast of northern Queensland, while further south, even reaching Tasmania (apparently) is *acuta*. No Antheneas (s.s.) are known from the long coast between Darwin and Cape Leveque but southwestward from the latter point are found at least four species *australiae, conjungens, elegans* and *polygnatha*, while from still further south off Geraldton, W. A., comes *obesa*. The locality whence *crudelis* comes is unknown. Since the genera Anthaster, Gymnanthenea and Pseudoreaster are exclusively Australian, it is evident that the tropical and subtropical coasts of Australia have proved a very favorable area for the speciation of Antheneinae.

While it is hoped that the key given above will prove of practical value in enabling collectors and workers to distinguish the different species of Anthenea, it is obvious that the sequence of species therein is in no way natural. It is not possible in the light of our present knowledge to arrange a natural sequence;

hence in the following pages, the 20 forms will be divided into 2 groups, the non-Australian and the Australian. In the first group the species will be discussed alphabetically and in the second, the known species will be discussed alphabetically, before the new forms are described.

NON-AUSTRALIAN ANTHENEAS

ANTHENEA CRUDELIS

Anthenea australiae var. *crudelis* DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. 53.

Although Döderlein considers the unique specimen on which this form is based, a variant of *australiae*, it seems to me better to treat it as a distinct species, since it is from an unknown locality. The huge and relatively few oral pedicellariae, the markedly pointed rays, and the few tubercles and numerous big pedicellariae of the aboral surface, distinguish it readily from all Australian Antheneas.

ANTHENEA FLAVESCENS

Hosia flavescens GRAY, 1840. Ann. Mag. Nat. Hist. **6**, p. 279.
Anthenea flavescens PERRIER, 1876. Arch. Zool. Exp., **5**, p. 92.

ANTHENEA FLAVESCENS var. NUDA

DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. 42.

All of the specimens hitherto referred to this species and variety are so small that I doubt whether their actual specific relationship will ever be satisfactorily established. The figures given by Döderlein represent two species not at all closely related (evidenced by the number and character of the superomarginal plates but even more strikingly by the difference in the form and length of the rays and the number, arrangement and surface of the aboral plates). The smallest specimen of *pentagonula* at hand (in the M. C. Z. series from Hong Kong) has R = 33–34 mm. and hence is considerably larger than the type of *nuda* (R = 27 mm.) but there is little doubt in my mind that Döderlein's specimen (from "Halmahera Strasse") is a young *pentagonula*. The individual which my German colleague refers to Gray's species *flavescens* is also very young

(R = only 37 mm.) and its identity is quite uncertain. Future workers should refrain from referring Antheneas to *flavescens* unless they have adult material. And the distinctive characters of such adults are as yet unknown!

ANTHENEA PENTAGONULA

Asterias pentagonula LAMARCK, 1816. Anim. s. Vert., **2**, p. 554.
Anthenea pentagonula PERRIER, 1876. Arch. Zool. Exp., **5**, p. 90.

This seems to be a common sea-star at Hong Kong, or at least it was 75 years ago, for the M. C. Z. has 24 specimens taken by Captain Putnam in 1861. There were originally many more but they have gone to museums in all parts of the world in exchange for more desired material. Young individuals have the arms relatively long and somewhat pointed and the short wide arms of the adult are not well-marked until R = 75 mm. As the "Albatross" took no specimens in the Philippines and the "Siboga" secured no adults in the Dutch East Indies, *pentagonula* does not appear to have ranged far from the mainland coast of Asia. The largest of the M. C. Z. specimens has R = 90–95 mm.

ANTHENEA REGALIS

KOEHLER, 1910. Ech. Indian Mus.: Asteroidea, p. 82.

This species seems to be confined to the coasts of India and Ceylon. A specimen in very poor condition with R = 100 mm., was secured by me on the beach at Madras, India, in August, 1932. It agrees well with Koehler's figure. A much smaller specimen from Ceylon, in excellent condition, with R = 47 mm., is also in the M. C. Z. collection. It agrees well in body form with the adult specimens but has not yet developed nearly so many tubercles; this is true also of Döderlein's Ceylon specimen with R = 51 mm.

It is unfortunate that Döderlein has referred very young Antheneas from the Philippines and from Torres Strait to this Indian species. Fortunately however he gives excellent photographs of these young individuals from which one may feel quite sure that neither is *regalis;* nor can they both well be referred to the same species; note the striking difference in the size and number of the papulae. It seems to me possible that the smaller specimen may be a young *sibogae* but I have no suggestion as to the identity of the larger.

Anthenea rudis

Koehler, 1910. Ech. Indian Mus.: Asteroidea, p. 86.

This species is based on two Antheneas from the Mergui Archipelago, which are too young for any accurate determination. There are 3 specimens at hand, all obviously young, which seem to belong here. The smallest belongs to the Australian Museum (J437) and has R = 14 mm.; the big pedicellariae of the oral surface indicate an Anthenea and the probability that it is *rudis* rests on the conspicuous presence of 3 large radial tubercles; the locality whence it came is unknown but Mr. Livingstone thinks it is non-Australian. The other 2 specimens are in the M. C. Z. collection; one with R = 31 mm. is from the Persian Gulf and the interbrachial arc is almost exactly as Döderlein figures it in a Ceylon specimen; the other, with R = 35 mm., is from Ceylon and differs from the smaller individual in having a conspicuous small tubercle (or very large isolated granule) on each superomarginal plate. Döderlein and Koehler refer to such tubercles in their descriptions but they do not appear in the figures given. Although all the known specimens of *rudis* are small (the largest is Döderlein's with R = 40 mm.), the species seems to be very well marked and worthy of recognition. The known range is from the Mergui Archipelago to the Persian Gulf.

AUSTRALIAN ANTHENEAS

Anthenea acuta

Goniodiscus acutus Perrier, 1869. Ann. Sci. Nat. (5), **12**, p. 280.
Anthenea acuta Perrier, 1876. Arch. Zool. Exp., **5**, p. 91.

Although Döderlein (1915) was unwilling to use this name because Perrier's description was so short and indefinite, the universal use of it, during 60 years, for the common Anthenea of the New South Wales coast justifies the continued use unless there is some reason why such usage is really incorrect. In this case, as in scores of others, the original description is not distinctive when all of the now known Antheneas are considered, but I find nothing in it which is inappropriate to some specimens at least of the New South Wales species. Moreover the name is particularly appropriate to this species, since the rays are as a rule more acute than in most Antheneas; certainly for none of the now known species is the name as generally appropriate. Döderlein has renamed the species (1915, p. 53) as *A. australiae* var. *sidneyensis*, regarding it as only a variety of the west coast species which he describes from Fremantle. The two have certain points in common but are, I think, really quite distinct.

Thanks to the Australian Museum, there are at hand from that institution, 39 specimens of *acuta*, making with the 11 in the M. C. Z., 50 specimens available for study. I greatly regret not having seen living or fresh material, nor are there any notes at hand on the color in life. The present series of dried specimens shows great diversity in size, form and tuberculation. The smallest has R = 16 mm., r = 8, while the largest have R = 120–130 mm. and r = about 70; one specimen with R about 120 mm. has R = about 1.6r (the condition of the specimen precludes exact measurements), while a specimen with R = 54 mm. has such long rays that R = 2.45r. When well preserved, large individuals of this species have a notably high disk, with the vertical diameter as much as 40–50 mm. when R = 120–130 mm. But many specimens when dried are very flat, and all young individuals with R less than 20 mm. have the disk but little elevated. As growth proceeds however the tendency is for the lesser radius (r) and the vertical diameter to increase more rapidly than R, so that full grown specimens have a flat, high body and relatively short, more or less triangular rays. There is great diversity in the number and size of tubercles and spinelets; very young specimens have but few and they are small; as growth proceeds there are divergent tendencies; in one line tubercles become more evident and greatly predominate, while on the other hand the spinelets increase more markedly and tubercles are relatively infrequent or even almost wanting. The reticulation of the aboral skeleton which is often marked in large specimens first begins to be evident when R = 75–80 mm. but there are many large adults which do not show it at all. Nothing has been recorded, so far as I know, of the color in life.

The 39 Australian Museum specimens at hand are from three points on (or off) the Queensland coast from Fraser Island southward; from five New South Wales localities (30 specimens from Port Jackson); and 1 large individual from Tasmania. One specimen is labelled "Port Chalmers, New Zealand" but as Anthenea is not included in Mortensen's recent careful revision of New Zealand sea-stars, verification of this label is necessary. The specimen is a small but typical *acuta*, and of course, Anthenea might occur on the New Zealand coast but hardly, one would think, at Port Chalmers.

ANTHENEA ASPERA

DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, 68, p. 35.

There are 5 adult specimens of this fine species in the Australian Museum all from Port Curtis, Queensland; the labels on two give the additional information, "12 fms." The smallest specimen has R = 85 mm., r = 47 mm., R = 1.8r; in the largest specimen, R = at least 125 mm. but the tips of the arms are so up-curved, it is impossible to give an accurate measurement, r = 70 mm., hence R = 1.8r as in the smallest. In other specimens R exceeds 1.8r slightly and in no case is it less. In the types R = 1.72 and 1.74 r but so much depends on the way that R is measured this difference is not important; if careful allowance is not made for the bending up of the arms at the tips, the present specimens have R = 1.7 r rather than 1.8 r. Besides the relatively long and pointed arms, the large and conspicuous superomarginal plates, usually closely covered with granules, and the aboral surface more or less closely covered with numerous pedicellariae, spinelets and pointed tubercles, distinguish this species. In the largest specimen the disk is elevated and the aboral skeleton somewhat reticulated as in *acuta*.

An Anthenea from Port Denison, Queensland, with R only 65 mm. and the color a dull brownish purple, is referred to *aspera* with some hesitation, as the upper ends of the superomarginals are not well covered with granules, and in this particular the resemblance to *crassa* is notable; on the other hand the rays are narrow and pointed and the covering of the disk is more like *aspera*. As the specimen is still immature, its identity cannot be positively determined.

The color of the dried specimens of *aspera* shows some diversity. The largest two are dark brown aborally with the superomarginals and the oral surface yellow-brown in marked contrast. Of the other specimens, the smallest is (as already stated) dull brownish-purple and the next larger is a dull light brown with a distinctly purplish or reddish cast. The remaining two are brown with little contrast between the upper and lower surfaces. According to a note on the label of one of these specimens the color in life was "Irregular mottling of brown and sage green; actinal surface yellow."

ANTHENEA AUSTRALIAE

DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, 68, p. 52.

Among the Antheneas dredged at Broome in 1932 are 3 typical examples of this well-marked species. In the largest R = 85–93 mm., r = 40, R = 2.25 r ±; the second specimen has R = 60–70 mm., r = 30; in the smallest, R = 47 mm. and r is about one-half as much. They agree almost perfectly with Döderlein's description and figures, and the color is now a typical "museum-color" or as Döderlein puts it "gelblich braun." It is greatly to be regretted that there are no field notes with these specimens to show what their color in life was. They were not distinguished when dredging from the numerous specimens of *conjungens* and other species which we were constantly taking.

Döderlein refers to Fremantle as the type locality for this species, and says there were many specimens. He adds that there was one small specimen from Shark Bay. It seems strange that we failed to take a single Anthenea in the vicinity of Fremantle either in 1929 or 1932. Furthermore there were none at the Museum of the University, nor did I note any in the Western Australian Museum. None have been sent to me by Professor Bennett. There is however a specimen in the M. C. Z., presented by Professor W. J. Dakin, which was taken "off Fremantle," a smaller specimen was dredged by Professor Dakin off the Abrolhos Islands. Evidently the species belongs to the west coast fauna and is not common as far to the northeast as Broome. Its occurrence at Fremantle, which is probably near the southern limit of its range, is apparently either very local or perhaps seasonal.

ANTHENEA CONJUNGENS

DÖDERLEIN, 1935. "Siboga" Ast.: Oreasteridae, p. 107.

Döderlein bases this species on a single specimen in the Hamburg Museum from "Australia" — no more definite locality is known. It proves to be one of the commonest sea-stars at Broome and a fine series of 24 specimens was taken during September, 1929 and June, 1932. There are also at hand, 2 adult specimens from the Australian Museum, which are labelled as from "Northwestern Australia." The smallest individuals have R = 23–25 mm. and r = 12–14 mm.; these little ones are notably well characterized by the fact that each aboral plate, with few exceptions, carries at its center a single, relatively large, rounded tubercle; now and then, a pedicellaria replaces or accompanies the tubercle and occasionally, the tubercle is replaced by a pedicellaria with a large granule on each side. In the smallest specimen, many plates on the distal portion of the arms are quite bare. One of the larger specimens is exactly the size of Döderlein's unique holotype (R = 75, r = 36 mm.) but is less flattened, the arms at middle being 13 mm. high; the vertical diameter of the disk is 19 mm.; this individual corresponds very closely in all details with the description and figure of the holotype. The largest specimen has become much flattened but even were that not so, the rays are notably short and wide; R = 125 mm., r = 65 and br = 65; R = 1.9 r or br; the rays are thus nearly triangular with the sides about 65 mm. long. At the other extreme is a half grown specimen with R = 65 mm., r = 27 and br = 27; R = 2.4 r or br; considering the rays as triangles, the sides are 40 mm., the base only 27. On the whole, *conjungens* is one of the least variable species of Anthenea, except perhaps in color. As already stated, the failure to recognize the number of species occurring at Broome and hence to distinguish between them has led to a regrettable untrustworthiness in my notes. As far as I can remember, there was great diversity of color among these common Antheneas, with shades of orange or red, purple and brown predominating. The dry specimens show much diversity as they are, ranging from pale brown to bright brown in the young, and from light brownish to orange or to purplish in the larger ones, usually with irregular dusky blotches.

Anthenea godeffroyi

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. 45.

This species rests on a single specimen with R = 79 mm., r = 44 mm. While closely allied to both *mertoni* and *sibogae*, the parallel series of very small tubercles gives a very different aspect to the dorsal surface. When the original description was published, the type of the species was supposed to be from Samoa, but in his latest publication Döderlein (1935) expresses the belief that it is from Australia, as it bears the same catalogue number (in Museum Godeffroy) as the type of *conjungens*, which is undoubtedly from Australia. As Anthenea is not known from east of the Great Barrier Reef region[1], it is quite unlikely that it occurs at Samoa. Moreover the obvious relationship of *godeffroyi* to the following species (*mertoni*, *sibogae* and *tuberculosa*) makes it highly probable that the unique holotype came from tropical Australia. It will not be surprising if it turns out to be an extreme variant of *mertoni*, a species of which we still know all too few specimens.

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[1] Records from New Zealand, Fiji and western coast of Mexico are highly improbable and require confirmation.

ANTHENEA MERTONI

Plate 7, figs. 1–2

KOEHLER, 1910a. Abh. Senckenb. Nat. Ges., **33**, p. 268.

This is a fine, well-marked species, originally described from a single adult specimen from the Aru Islands. Döderlein (1915) records a somewhat smaller specimen in the Berlin Museum from the "Gazelle" collection in Mermaid Strait on the northwestern coast of Australia. I cannot avoid the feeling that there is some mistake about this locality, for among all the scores of Antheneas collected in 1929 and 1932 along the northwestern coast, both east and west of Broome, no individual was taken which could possibly be referred to *mertoni* or one of its near allies, so I find it hard to believe that it occurs in Mermaid Strait or on any part of the Australian coast, west of Cape Leveque.

There are at hand however half a dozen specimens of *mertoni* which demonstrate its occurrence in the Gulf of Carpentaria, and as far west as Darwin. In the Australian Museum collection are 4 specimens; 3 from Mapoon on the eastern side of the entrance to, and 1 from Pearce Island, Sir Edward Pellew Group, far down in, the Gulf of Carpentaria. The specimens from Mapoon have numerous more or less capitate aboral spines, and the distal aboral plates on the arms have few and large tubercles. In 2 of the Mapoon specimens R = 65–70 mm., r = 37–40, so that R = 1.7 r ±, but the third is much smaller with R = 50 mm. and r = 26, so that R is nearly equal to 2 r; moreover the rays are narrower and more pointed than in the larger specimens, as is to be expected in young individuals. The specimen from Pearce Island is in very poor condition, badly water worn, but it is a large individual with R = 83 mm. and r = 50.

At Darwin, we were so fortunate as to dredge near Channel Island, in July, 1929, a very fine specimen of this Anthenea. Mrs. Clark made a color sketch of it as soon as possible, which was fortunate, as the present "museum color" gives no idea of its handsome appearance in life. The upper surface was gray, with large, irregular blackish-brown blotches; the oral surface was light reddish-buff. In structural details and appearance, this specimen corresponds very closely to Koehler's type specimen, which was a little larger with arms a little longer. The Darwin specimen has R = 85, r = 50 mm. Among all the scores of Antheneas subsequently collected in the Broome region, we never saw one that resembled this specimen in either form, tuberculation or color. We dredged near Shell Island at Darwin however a very small Anthenea, with R = 10 mm., r = 5.5 mm., which I believe is a young *mertoni*, although of course, it does not yet show any distinctive features. In April, 1936, Mr. Livingstone sent me 2 young specimens from Darwin acquired by the Australian Museum in 1935.

ANTHENEA SIBOGAE

DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. 47.

Among the specimens in the Australian Museum collection is an Anthenea (with R = 65 mm.) from Albany Passage, northern Queensland, 9–12 fms., which I am referring to this species with some misgiving. Another specimen of the same size, but with wider more rounded rays, as in *mertoni*, is also in the collection and is labelled Thursday Island. The two specimens are so alike in the form and covering of the superomarginal plates that I feel sure they are the same species, and in this character of the upper marginal series they resemble Döderlein's figure of *sibogae* so closely, and differ so evidently from the much coarser granulation of *mertoni* that it seems best to refer them to *sibogae*. But it must be remembered that *sibogae* is as yet known from only a single, large specimen, in which R = 102 mm.; the arms are strikingly slender, though short, and the interbrachial arcs notably flattened. If these features are constant, the species is very well characterized but the specimens at hand make one dubious as to their constancy, and if they are not constant, it is doubtful whether *sibogae* and *mertoni* can be maintained as distinct species.

In this connection, it is important to note that the Antheneas listed in my Torres Strait Report (1921, p. 29) as *tuberculosa* Gray are not that species (unless *mertoni* and *sibogae* are both synonyms thereof, as I believed in 1921 and still think is by no means improbable) but are evidently identical with the Australian Museum specimens which I am here calling *sibogae*. One of these Torres Strait specimens is young and is figured by me in its natural colors, which are bright and varied — very different from the Darwin *mertoni* or indeed from any other Anthenea I have ever seen. On account of this striking color difference, and the differences in superomarginal plates and aboral tuberculation, it seems wisest to let the three species stand but much more material is needed before their validity can be considered demonstrated.

ANTHENEA TUBERCULOSA

GRAY, 1847. Proc. Zool. Soc. London, p. 77.

The diagnosis of this species was published in June and in September again in the Annals and Magazine of Natural History (1847, **20**, p. 198). Only a single specimen was in Gray's hands at the time and that was from Port Essington, Northern Territory, whence naval officers sent many a notable sample of the Australian fauna home to the British Museum. Later on (1866) Gray published a good figure of this individual and he does not seem to have had any other available specimen. Yet Perrier (1876, p. 88) refers to "echantillons desechés" as "les types" of Gray and describes under the name *tuberculosa* a sea-star which is apparently not Gray's species, quite a different thing to which Döderlein has since (1915, p. 52) given the name *australiae*.

Apparently the true *tuberculosa* is a rare species, for Döderlein has seen but a single specimen, which he (1935, p. 106) records as taken by the Siboga at Pulu-Jedan in the Aru Islands; excellent figures are given. There are no specimens in the museums at either Sydney or Perth. In the M. C. Z. collection there is an Anthenea from an unknown locality, which I am referring to this species because of its very marked resemblance to Döderlein's figures. It has R=67, r=38 mm. (R=1.75 r), and is perfectly flat aborally with a vertical diameter of 16 mm. The granulation, or better, the tuberculation of the superomarginals is even coarser and more sparse than in *mertoni* and the distal aboral plates of the arms seldom have more than one large tubercle. This specimen probably came into the M. C. Z. collection from Ward's Natural Science Establishment, Rochester, N. Y.; Mr. Ward made a trip to Torres Strait in 1896 and collected much marine material, some of which subsequently came to the M. C. Z. and this Anthenea was probably acquired then. Although it is easily distinguished from all the specimens of *mertoni* and *sibogae* that I have seen, it is not unlikely (as already stated) that the three nominal species are in reality identical, as I held in my Torres Strait Report (1921, p. 29).

ANTHENEA VIGUIERI

DÖDERLEIN, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, **68**, p. 34.

This species was established to provide a name for a sea-star misidentified by Müller and Troschel, and later by Perrier, and by Viguier. The specimen is in the Berlin Museum and has been figured by Döderlein. A specimen, not quite so large, is in the M. C. Z. from Restoration Island, northern Queensland. It was secured from Ward's Natural Science Establishment, Rochester, N. Y., in 1896. There are no specimens in the Australian Museum. Whether the species is really valid or only an extremely non-tuberculated form of *tuberculosa* remains to be demonstrated.

ANTHENEA ACANTHODES[1] sp. nov.

Plate 18, fig. 2

$R = 97$ mm., $r = 55$ mm., $R = 1.76\ r$. Disk high, 40 mm. in vertical diameter. Arms correspondingly arched at base but becoming flattened rather abruptly 35–40 mm. from the tip. Aboral surface of disk and basal part of arms, covered with big bluntly pointed tubercles or low, stout spines; on the basal part of arms these form 9–13, more or less distinct, nearly parallel series. Distal part of arms covered with irregular tuberculated plates as in the *mertoni* group; the tubercles on these plates are coarse and rounded like those on the superomarginal plates. The latter are rather few (14 or 15 on each side of a ray), vertical in position, much higher than long, conspicuously covered, except at margins, with coarse tubercles, the uppermost largest. Inferomarginal plates correspond in size and position; the outer end and distally the whole plate carries coarse tubercles; in the interbrachial arc the inner portion of the plate is closely covered with small tubercles like those of the actinal intermediate plates. Pedicellariae on marginal plates (in both series) few and small, often wanting altogether. Oral surface not peculiar in any way but typically Anthenea-like. Adambulacral armature stout but not remarkably so. Color of dry specimen, brown, lightest orally, darkest on aboral surface of rays.

Holotype, Australian Museum No. J5367, from Port Curtis, Queensland.

This is the most sharply defined species of Anthenea, occurring in Australia. It looks as though it might conceivably be a hybrid between *crassa* and *mertoni* but I do not believe for a moment that this is the case.

ANTHENEA CRASSA[2] sp. nov.

Plate 18, fig. 1

R about 115 mm. (along the adambulacral furrow, the arms are 125 mm. long, on the aboral surface, about 105 mm.); $r =$ about 55 mm., $R = 2.1\ r$; at base of arm, br is rather more than r. Aboral surface low and somewhat flattened in holotype but in some specimens it is considerably arched; one with $R = 90$

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[1] *ἀκανθώδης* = *full of thorns*, in reference to the remarkably spiny aboral surface.

[2] *crassus* = coarse, in reference to the large tubercles and granules of the aboral surface and superomarginal plates.

mm. has v.d. about 30 mm. In this specimen a certain amount of reticulation of the aboral skeleton is evident but no other specimen shows it. Aboral surface of disk and rays covered with coarse tubercles or stout blunt spines, which, on the basal part of the rays form about 9 more or less definite series; in the holotype, which has the heaviest tubercles (often over 2 mm. high and more than 2 mm. in diameter at base) the series are not very well defined but can be distinguished along the median radial line. In all the paratypes, the tubercles are smaller though they may be 2 mm. high. Pedicellariae aborally are very few in the holotype and some other individuals, but in several specimens they are numerous. Superomarginal plates about 15 in number, lying more or less on the aboral surface in the interbrachial arcs but becoming more vertical distally; in the specimen with the high disk, they are nearly vertical even in the interbrachial arc. Distally they are pretty well covered with coarse granules but basally the margins are more bare and the uppermost granules are much the largest and form a single vertical series of 2–4. Inferomarginal plates more numerous (16 or 17) and not corresponding exactly in position with the upper series; they are closely covered with granules, coarsest at the outer end, and carry several (2–6) pedicellariae. Oral surface not peculiar but the adambulacral armature is exceptionally heavy, all the spines, especially the marginal series, being more than usually stout. Color of dry holotype, dark brown but some of the paratypes are more yellow-brown.

Holotype, Australian Museum No. J5368, from Port Curtis, Queensland.

There are 7 paratypes, all from Port Curtis, where this species evidently replaces *acuta* of the more southern coast. The smallest has R = 70 and r = 35 mm.; the tubercles are of course much smaller than in the holotype but otherwise the resemblance is marked. One individual with R = 95–100 mm. is notable as having the longest arms relatively of any Anthenea examined; r is only a little more than 40 mm., hence R = 2.4–2.5 r. The narrowness of the arms is indicated by the fact that 40 mm. from the mouth br is only 35 mm.

An Anthenea from Port Curtis, with R = 105 mm. has given much difficulty in its identification but owing to the position, character, and armature of the superomarginal plates, it is here referred to *crassa*, with the suggestion that it is a hybrid between *crassa* and *aspera*, the two common Antheneas at Port Curtis. The color (brown aborally, with the marginal plates and oral surface, yellow-brown in rather sharp contrast) is like that of the large specimens of *aspera*, and the attenuate, somewhat pointed rays, are also like that species. Moreover there are numerous pedicellariae and few spinelets on the aboral surface as in *aspera*. But because of the superomarginal plates, it cannot be placed in that species without qualification. The possibility of its being a hybrid seems reasonable.

ANTHENEA ELEGANS[1] sp. nov.

Plate **18**, fig. 4

R = 120 mm., r = 60, R = 2 r; br (at 60 mm. from mouth) 52 mm. Disk moderately elevated, v.d. = 32 mm. Nearly all of the paratypes are flat or only a little convex. Disk covered with small pedicellariae, spinelets and tubercles, rounded or bluntly pointed; if pedicellariae are very numerous, the spinelets are rather few but if pedicellariae are few the spinelets are very numerous. In the holotype, the tubercles are large, up to 2 mm. in height and in diameter; they are arranged in 9–11 well separated series on each arm and between them the pedicellariae are excessively numerous. Paratypes not essentially different but the tubercles are smaller and more crowded and there are not so many series on each arm. Superomarginal plates about 18, much wider (in the interbrachial arc) or higher (distally) than long, well covered with granules, largest on convexity of the plate, smallest close to the margins; in young specimens the marginal portions of each plate are quite bare and the uppermost granules are enlarged; distally, in adults, some or many granules are enlarged; especially on upper half of each plate. In many cases, the superomarginals are nearly vertical even in the interbrachial arcs but they always form a conspicuous border to the disk and rays. Many aboral plates near arm tip are somewhat enlarged and carry several tubercles and granules as in the *mertoni* group, but the character is well-marked only in big adults. Inferomarginal plates notably large, uniformly and closely granulated, with a single small pedicellaria or none (in the holotype, more commonly, none); on a few plates at the middle of the interbrachial arcs, the granules at the outer end are notably enlarged and in some young individuals the same is true; in most adults however, this does not seem to be characteristic. Oral surface as usual in the genus, but the adambulacral armature is very well developed and the series of spines back of the marginal series contains 3, and often 4, more or less flattened spines. Color (dry) more or less dull purple-brown, but lightest on marginal plates and near arm-tips.

Holotype, M. C. Z. No. 3192, from Broome, Western Australia, 5–8 fms., June, 1932.

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[1] *elegans* = handsome, in contrast to *crassa*, in reference to its more beautiful form and finer appearance.

The holotype is much the largest specimen but there is a good series of 16 paratypes with R ranging from 50 to 100 mm. On the whole there is relatively little diversity in the form, or in tuberculation of the aboral surface, but there is a good deal of diversity in the position of the superomarginal plates; the degree to which they form a conspicuous part of the dorsal surface depends in part on the care with which the specimens were prepared, including the rapidity or slowness of the drying. But it also depends in some degree on the size of the individual and the convexity of the disk.

This species is nearly as common at Broome as *conjungens* but adult specimens of the two species are easily distinguished. Individuals with R less than 50 mm. are more easily confused. My field notes however give no clue as to the colors in life of *elegans*; presumably they were as diversified as in other species.

The smallest specimen at hand is a curious monstrosity, as one of the ambulacra forks 6 mm. from the mouth and gives rise to a sixth ray slightly smaller than the other five; it has 13 superomarginals on each side whereas the other rays have 15.

ANTHENEA OBESA[1] sp. nov.

Plate 19, fig. 1

R = 100 mm.; r = 48 mm.; R = more than 2 r; br at 48 mm. from mouth, 37 mm.; vertical diameter of disk about 33 mm. Aboral surface covered with a smooth, thin skin, with very few pedicellariae or small spinelets but with about 230–250 coarse, blunt or truncate tubercles sparsely and irregularly distributed over the disk and the proximal portion of the arms; these tubercles are 2–3 mm. high and up to 2.5 mm. in diameter; they tend to form 2 parallel series on each ray. Superomarginal plates about 16 on each side of an arm, very low, (longer than high) on basal half of arm but becoming higher than long distally; in the interbrachial arc the plates are scarcely visible from above and there is usually but a single small tubercle on each plate; sometimes however a second small tubercle, or several granules may be present; distally 5 or 6 coarse granules occur on each plate and the plates themselves form a conspicuous margin to the terminal half of the arms. Inferomarginal plates moderately large, quite uniformly covered with coarse granules. Oral surface as usual in Anthenea but adambulacral spines in all three series are unusually short and stumpy. Color in life is recorded as "scarlet or crimson-red;" the dry specimens are light reddish-brown above, very much lighter, almost a reddish-white, below.

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[1] *obesus* = fat, in reference to the high disk and arms.

Holotype, Western Australian Museum, No. 4920, dredged by the "Endeavour" off Geraldton in 29 fms.

There is a single paratype of this strongly marked species taken at the same time and place as the one described above. It is somewhat smaller (R = 83 mm.) and there are fewer aboral tubercles, but there are a good many more granules on the interbrachial superomarginal plates.

ANTHENEA POLYGNATHA[1] sp. nov.

Plate **18**, fig. 3. Plate **19**, figs. 2–3

R = 125 mm.; r = 60 mm. R = 2 r or more; br at 60 mm. from mouth, only 40 mm. These are the measurements of the holotype but this Anthenea seems to be dimorphic and a specimen of the other form has R = 115 mm.; r = 60 mm.; hence R is a little less than 2 r; br at 60 mm. from the mouth is 50 mm. or more. In the long armed form, the interbrachial arc has a nearly straight margin 40–50 mm. long while in the other, the straight portion of the interbrachial arc is only 20–25 mm. and even then it is not really straight but slightly concave. The 3 smaller specimens at hand, with R = 78, 93 and 97 mm. all have wide rays and curved interbrachial arcs. Of 2 larger specimens, one with R = 130 mm. is distinctly narrow-armed while the other with R = 127 mm. is more of the broad-armed form, though it has interbrachial arcs that are nearly straight for 40 mm. It is possible that this difference in form is associated with sex and the matter deserves investigation whenever fresh material is available.

Aside from this difference in form, the 7 specimens at hand show little diversity. The aboral surface is covered with hundreds of low spine-like tubercles, smallest in the small specimens, largest in the holotype. There is more or less evident a tendency to have these tubercles form radiating parallel series running out from the center of the disk. On the arms these series are usually quite evident, more so in the smaller specimens than in the larger. In all the specimens, the tubercles along the sides of disk and arms (i.e. just above the superomarginal plates) tend to be longer and more conspicuous than elsewhere, and this is a rather good distinguishing mark when specimens are mixed with *conjungens*, *elegans* and *australiae*. There is some individual diversity as to the degree to which the tubercles are pointed; in some specimens they are quite sharp.

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[1] πολύς = *many* + γνάθος = *jaw*, in reference to the very large number of pedicellariae on the oral surface.

Superomarginal plates small, in the interbrachial arc almost as long (or high) as wide, becoming larger distally but never forming a conspicuous part of the aboral surface. Their position ranges from nearly horizontal in one arc of the holotype which is a flat, slowly dried specimen, to perfectly vertical in most of the others. There is little doubt that in life, they are normally nearly or quite vertical in the interbrachial arcs, and are but little visible from above. They are more or less covered with granules; on the lower half the granules are small and cover the plate well but on the upper portion the granules are larger and the uppermost is almost a tubercle, above and on each side of which the plate is quite bare; besides the granules each plate bears 1–5 pedicellariae of diverse sizes. Inferomarginal plates considerably larger than those of the upper series, completely covered with small granules and pedicellariae; the number of pedicellariae on each plate ranges from 4 up; in the holotype, many of the plates carry 15–20 pedicellariae. Actinal intermediate plates with numerous pedicellariae, as many as 4 occurring on some plates and rarely does a plate carry only a single large pedicellaria. Adambulacral armature in three series as usual but the spines of the second series are unusually long and flattened; even in the smallest specimen this feature is noticeable. Color in life purple or violet or orange; as in the other species of Anthenea at Broome, there seems to be no constancy or distinctiveness in the color. The dried specimens still show some traces of purple or orange, but in general they are "museum color."

Holotype, M. C. Z. No. 3196, from Broome, Western Australia, 5–8 fms., June, 1932.

Of the 6 paratypes, the 2 largest were presented to me in 1929 by Colonel W. O. Mansbridge, who informed me that they came from the Lacepede Islands, north of Broome. We did not meet with the species that year but in June of 1932, we took the holotype and the other paratypes in our dredging south and southwest of Roebuck Bay. The excessive development of pedicellariae, the long adambulacral spines and the increased length of the aboral tubercles above the superomarginal plates combine to make this species easy to recognize in spite of its dimorphic tendency.

OREASTERIDAE

PROTOREASTER NODULOSUS

Pentaceros nodulosus PERRIER, 1876. Arch. Zool. Exp., **5**, p. 53.
Protoreaster nodulosus DÖDERLEIN, 1916. Zool. Jahrb.: Syst., **40**, p. 420.

Although hitherto considered a rare species, this is a common sea-star in the Broome region and specimens of very diverse size and almost equally diverse color were constantly taken during our dredging. It was also found at or above low water mark during the extreme tides of September, 1929. The smallest specimen has R = 40 mm., r = 16, R = 2.5 r; in the largest individual at hand R = 155–160 mm., and r = 63 mm., so the proportions are essentially the same. In a perfectly tetramerous specimen from the Lacepede Islands, R = 90 mm. and r = 30, hence R = 3 r, and in a hexamerous specimen also from the Lacepedes, R = 85 mm. and r = 35, hence R is not quite equal to 2.5 r. On the whole, the form, proportions and tuberculation show rather notable constancy. The two largest specimens however show interesting details of tuberculation; in the larger the 5 big hemispherical radial tubercles which are so distinctive a feature of nearly all individuals are practically wanting in two radii and in the other three are inconspicuous, not nearly so large as the adjoining tubercle which begins the characteristic carinal series; in the other specimen, the large tubercles of the carinal series are very irregular in form, number and arrangement, the big radial tubercles are wanting or displaced, and there are 5 large interradial tubercles; on one arm the proximal tubercles of the carinal series are about as usual, on two, they are wanting and on two, they are abnormally numerous, of diverse sizes and crowded out of position. In this latter specimen, there are notable irregularities in the distal inferomarginal series.

My field notes describe the color of a number of specimens but the diversity is so striking it has no significance; in general it may be said that the aboral surface is usually brown, gray or green of some shade, with the papular areas a different shade from the plates and the papulae dark; the large tubercles usually stand out in a distinctive shade or color; in one extreme specimen they were purplish-black with the rest of the aboral surface cream-white. The oral surface is more constant; it is fundamentally cream color but shades of the aboral side pass over onto it more or less by way of the interbrachial inferomarginals, and in highly colored specimens the central portion of each actinal intermediate plate may be quite evidently tinted with some shade of color. In all specimens, of all sizes, the adambulacral armature is white or at least cream-color, and the pedicels are white (more or less translucent, of course) with the terminal suckers bright light violet. It is curious how constant this color of the pedicels is.

There are 25 specimens of *nodulosus* at hand, of which the 2 non-pentamerous specimens from the Lacepede Islands, mentioned above were gifts from Colonel W. O. Mansbridge; 5 adults were taken at False Cape Bossut in September, 1929; 2 large adults were collected at Augustus Island by Captain Bardwell in October, 1933, and the remainder, including half a dozen very young specimens, were taken at or near Broome, in 1929 or in June, 1932.

PENTACERASTER AUSTRALIS

Oreaster australis LÜTKEN, 1871. Vid. Med., **23**, p. 253.
Pentaceraster australis DÖDERLEIN, 1916. Zool. Jahrb.: Syst., **40**, p. 433.

Mr. Melbourne Ward has kindly sent a small Oreasterid with R = 42 mm. which seems to be the young of this species, common at several points on the Queensland coast. Livingstone's (1932) careful description of the growth stages and his admirable figures leave no doubt as to the identification, but I have not hitherto seen so small a specimen.

PENTACERASTER GRACILIS

Oreaster gracilis LÜTKEN, 1871. Vid. Med., **23**, p. 260.
Pentaceraster gracilis DÖDERLEIN, 1916. Zool. Jahrb.: Syst., **40**, p. 437.

In 1929, Colonel W. O. Mansbridge of Broome, presented me with an unmistakable specimen of this fine species taken at the Lacepede Islands, north of Broome. One of the very few disappointments which we met with in our collecting that year was the failure to find even one specimen of this rare and much-desired form. The disappointment was deepened in 1932 when a month of very extended and intensive dredging failed to reveal a specimen. The few specimens hitherto known have come from the coast of Queensland. There are none in the Australian Museum and only 3 in the M. C. Z.; one of these, a small one with R = 133 mm., is from an unknown locality but the 2 large ones, with R = 200–235 mm., are from Warrior Reef, in Torres Strait, where they were secured in 1896 by Mr. Henry A. Ward. The specimen at hand from the Lacepede Islands has R = 220 mm., r = 100 mm. The color of the dry specimen is a dull purplish-brown, which suggests that the color in life was a brick-red.

Culcita novaeguineae

Müller and Troschel, 1842. Sys. Ast., p. 38.

Among the valuable discoveries which Captain Bardwell made during his collecting at Augustus and Champagay Islands, none surprised me more than that of Culcita of which he sent 5 specimens. They are so similar to those in the M. C. Z. from Torres Strait, that the identification seems beyond question but the extension of range is very remarkable, as I can find no records for Culcita nearer than Torres Strait, 1200 miles or more to the east.

The specimens at hand, in their dry and flattened condition range from R = 70 to R = 115 mm. All are markedly pentagonal and all but one have the sides nearly straight; in one, the concavity of two sides is as much as 15–20 mm. In the smallest specimen the marginal plates are very conspicuous, but in none of the others are they visible; there are 12 on each side of the pentagon in the upper series and 14 or possibly 16 in the lower; the inferomarginals near the tip of the arm are ill-defined. This smallest specimen is quite brown but the others are more definitely gray; all have more or less variegation or tinting with yellowish or brownish.

OPHIDIASTERIDAE

Austrofromia polypora

Fromia polypora H. L. Clark, 1916. "Endeavour" Ech., p. 51.
Austrofromia polypora H. L. Clark, 1921. Torres Strait Ech., p. 48.

Mr. Glauert has kindly loaned me a small specimen of this still little known species, taken at Rottnest Island, and belonging to the Western Australian Museum. It is considerably distorted but R is about 65 mm. and r is almost one-fifth as much; at base, the arms are 12 mm. in diameter but they taper rather rapidly to a blunt tip about 5 mm. across. The specimen is now museum color with a faint reddish tinge but there is no indication of what the color was in life.

Nardoa pauciforis

Linckia pauciforis von Martens, 1866. Arch. f. Naturg. **32**, pt. 1, p. 69.
Nardoa pauciforis Sladen, 1889. "Challenger" Ast., p. 412.

The range of this species is extended far to the southward by its discovery near Mackay, Queensland. Mr. Ward has sent a very typical specimen with

R = 110–115 mm., bearing the label "Coral reef, Seaforth Island near Lindeman Island, Cumberland Group, Queensland, July, 1935."

LINCKIA GUILDINGII

GRAY, 1840. Ann. Mag. Nat. Hist., 6, p. 285.

The discovery of this tropicopolitan sea-star at Lord Howe Island was not very surprising but to find it among the species occurring at Broome was most unexpected. Still more interesting is the color in life of the specimens taken at Broome. The first specimens taken were brought up by our diver, Norman Whitworth, from 4–5 fms. in Lagrange Bay; there were 3 lying exposed on the sandy bottom and Whitworth said he saw no others, yet oddly enough one has 4, one has 5 and one has 6 arms. The 4-armed one has R = 195 mm. on the longest ray but only 155 on two others and the fourth was bitten (or broken) off close to the disk but was healed and beginning to regenerate; the arms are 15–18 mm. in diameter near base and taper evenly to the tip; there are 3 madreporites, subequal and normal, 1 in an interradial area on the disk, the other 2 in the adjoining interradius, on the side of the base of a ray. The 5-armed individual is more unsymmetrical in arm-length yet it has only a single madreporite. Beginning to the right of the madreporite, the length of R is 175, 165, 178, 102 and 84 mm. and the diameter of the arms near base is 13–14 mm. The 6-armed specimen has 2 madreporites; the ray between them has R = 100 mm.; the following rays (to the right) have R = 165, 185, 125, 155 and 180 mm. In color these 3 specimens were alike; they were "very blue, with a greenish cast," but distally the arms had more of a violet tinge. The blue was not so deep a shade as in *L. laevigata*. On drying, the color became light blue but soon changed to gray with a violet tinge which becomes more or less red-violet distally and orally; there are also distinct red-violet patches, 1–5 mm. across, on the oral surface. There is no record of blue Linckias in the West Indies.

Off Cape Vilaret, in about 5 fms., Whitworth brought up a young *guildingii*, which was violet, not at all blue; it dried reddish but soon became violet-buff, more nearly violet on disk. A small adult specimen (R = 100 mm.) in the M. C. Z. from Moraine Cay, Bahama Islands, is very distinctly violet, even in its present dry condition and must have been much the same color in life as this Cape Vilaret specimen. The latter has 2 small madreporites, one almost rudimentary, and the rays measure 87–112 mm. in length, 6.5–8 mm. in diameter. Mr. Bourne gave me another specimen of *guildingii*, which he collected near Broome and dried;

it is much distorted, but has a single small madreporite, and 5 arms, of unequal length, 2 bitten (or broken) off near the disk; the most perfect arm is about 170 mm. long and 17 in diameter; the color of this specimen is a light brown, similar to that of the West Indian specimens at hand. Unfortunately Mr. Bourne did not recall the color in life. Another specimen from Broome has been loaned by the Perth Museum; it is now a rather bright yellow brown especially on the oral side; there are 2 madreporites with a ray between them, and 6 arms, 70–170 mm. long.

The single specimen from Lord Howe Island is rather small but quite symmetrical, with 5 arms, and 1 madreporite; R = 90–95 mm. It was given me by Mr. Ivor Maidment who picked it up on Middle Beach; he reports the colors as "brown above, almost red below, along furrows." It is now however in poor condition and quite bleached, having been obviously exposed to rain and sun. In the Australian Museum there is a fine 6-rayed specimen from Lord Howe, having R = 100 mm., more or less.

BUNASTER VARIEGATUS[1] sp. nov.

Plate 22, fig. 1

Rays 5. R = 23 mm., r = 6, br = 6, hence R nearly = 4 r or 4 br. Aboral surface well covered by the superomarginal plates of which there are about 16 or 17 in each series, and a single carinal row of 16 or 17 similar plates; the superomarginal plates increase in size distally, so that the most distal are considerable larger than the ones near disk; this increase in size distally is not so evident in the carinal plates; on the basal half of the arm, there is, on each side of the carinal plates, a series of 10–12 very small plates; all of the aboral plates lie close together and the narrow areas between are closely covered with minute granules like scales, set more or less on edge. No pedicellariae, or "ball and socket" plates, have been detected on the holotype or any other specimen either aborally or orally although prolonged search with magnifications up to 90 diameters has been made. Papulae are present singly on the arms in most of the angles between superomarginal and carinal plates. Terminal plate large, nearly circular, swollen. Inferomarginal plates 18 or 19 in number, largest near middle of arm, smallest basally, the distal ones more or less circular. Intermarginal plates 8 or 9 extending out to middle of arm. Intermarginal papulae relatively large and conspicuous, at least distal to intermarginal plates.

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[1] *variegatus*, in reference to the diversified coloration.

Actinal intermediate plates in two series but the outer only extends to about the tenth inferomarginal. There are 12–15 large single papulae, in a well spaced series, below the inferomarginals. Adambulacral armature as in other Bunasters, 2 furrow spines, short, rounded, subequal, on each adambulacral plate and a large subambulacral spine, almost as wide as long, so the series is quite crowded. Oral plates with 3 marginal spines but none on surface. Color of disk and tips of arms rose-red (purplish-red or dull brown in paratypes), base of arms cream-white with more or less brown variegation; remainder of arm variegated with brown, reddish and white; oral surface whitish more or less variegated with brown. There are 5 specimens which show this rather pretty coloring. The other 8 are bleached, to a uniform pale yellow-brown in 3 cases but more nearly white in the others. Apparently the variegated specimens were dried either without being placed in alcohol or before it had affected the color perceptibly; the others were probably bleached in alcohol and later dried.

Holotype, M. C. Z. No. 3214, from Bunkers Bay, Western Australia, in a shallow intertidal pool. E. W. Bennett leg. et don.

This Bunaster is almost exactly the same size as the type of *B. lithodes* Fisher, with which it has been critically compared. The differences are obvious: the wide (almost circular) subambulacral spines in a crowded series are very different from the narrow, well-spaced spines of *lithodes;* the outer actinolateral series of plates is much shorter and the individual plates smaller than in the Philippine species; the granulated areas between the skeletal plates are much narrower and less extensive in the Australian species, the papulae are single and there are no pedicellariae; the color is notably different, more rose or purple in *variegatus*, but whether this difference is of any value, only large series of specimens can tell.

In the light of the material now at hand, there is no doubt that the Bunasters taken by Professor W. J. Dakin at the Abrolhos Islands, which were recorded as *lithodes* (H. L. Clark, 1923, p. 241) are really immature *variegatus*. Comparison of one of them with a *variegatus* of similar size indicates this clearly.

Besides the holotype there are 12 specimens of Bunaster in the present collection, all of which, except the very young, with R less than 12 mm. may be considered paratypes. They were taken as follows:

Western Australia: Rottnest Island, near Bathurst Point, December, 1929 and January 1930. Miss Glauert and L. Glauert leg. 7 specimens, 1 adult and 6 young (2 in natural colors apparently).

Same locality but taken in 1931. 4 specimens, young, 1 in natural colors, apparently.

Bunkers Bay, "shallow intertidal pools with loose rocks and a little muddy sand; small clusters of a short brown alga in pools." 1 adult specimen (holotype) and 1 very similar but not so large.

LEIASTER LEACHII

Plate 9

Ophidiaster leachii GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 284.
Leiaster leachii DE LORIOL, 1885. Mem. Soc. Phys. Hist. Nat. Genève, **29**, No. 4, p. 40.

On April 21, 1932, one of our last days at Lord Howe Island, Mr. Robert Baxter, whose knowledge and ready assistance had been invaluable during our stay, brought in a superb sea-star, with R = 275 mm. (diameter of arms less than 20 mm.), which he had "after half an hour's work, dug out of the coral rock near shore on the South Reef." The color was striking, a brownish-buff, irregularly blotched and spotted with crimson; the big madreporite was red-violet. It was new to him as well as to us, though there was no doubt of its being a Leiaster. A few days later, in looking over sea-stars in the Australian Museum, a Leiaster from Lord Howe was seen which appeared to be *L. speciosus* v. Mart. Comparison of my Lord Howe specimen with the specimen of *speciosus* in the M. C. Z., secured at the Murray Islands in 1913 (See H. L. Clark, 1921, p. 74) raised the question as to the validity of von Marten's species. Specimens of Leiaster are unfortunately very rare (there are only 3 in the M. C. Z.) but after consideration of those I have seen in life and in museums, and of the published descriptions and figures, I must confess I can find no difference that is trustworthy between *speciosus* and *leachii*, and the latter name unfortunately has priority.

Owing to the length and somewhat flaccid character of the arms, *Leiaster leachii* undergoes considerable change of form when preserved; the shrinkage of the Lord Howe specimen in drying is about 10% in length of arms with no corresponding decrease in diameter; the arms are thus shorter and stouter than in life. A few small pedicellariae are present on the distal part of the arms. The color is now a uniform dark and dingy brown-red becoming a light red, reddish-yellow and finally dull yellowish distally. But the specimen was dried hastily and under adverse conditions, as we were packing up to leave the island.

Mr. Livingstone has written me that during the Christmas holidays of 1932 he took "another beautiful Leiaster" at Lord Howe, with R = 226 mm. The color in life was "surface covered with blotches of orange, magenta and crimson, the last two colours predominating. The colouring is extremely vivid and most strikingly beautiful." It is interesting that this specimen has the same type of coloration as that of the specimen taken in April, whereas the Murray Islands specimen was uniform crimson. One can but wonder whether the unicolored and particolored forms are really one species!

OPHIDIASTER ARMATUS

KOEHLER, 1910a. Abh. Senckenb. Nat. Ges., **33**, p. 277.

Among the sea-stars sent me from Lindeman Island, near Mackay, Queensland, by Mr. Melbourne Ward in 1934, are two specimens which after much hesitation, I refer, for the present, to this species. The large one has R = 66 mm. and hence is a little larger than the largest of Koehler's types. The breadth of the arm at base is nearly 9 mm., so the proportions are very similar to those of *armatus*. But the arms are more slender and tapering and the groups of papulae are much less noticeable than in Koehler's figures. However the specimen in hand is dry, while Koehler's photograph is obviously of a specimen not yet dried. No pedicellariae were found in the types of *armatus*; there are many in the Lindeman Island specimen. The color of *armatus* was deep yellowish-violet with 2 or 3 faint, irregular yellowish bands on the distal part of the arms. The present dry specimen is an almost uniform deep brown-violet with the faintest possible indication of banding on the arms, visible only in particularly good light.

The smaller specimen from Lindeman Island has R = 38 mm. It is a dull light brown, more or less evidently variegated with a darker more purple shade; on the arms these darker blotches might be considered as indefinite bands; oral surface somewhat lighter. The series of papular groups on the oral surface of base of arm, which are very evident in the larger specimen, can scarcely be detected in this small one, which is thus much like a Tamaria. The projecting pointed tubercles on the marginal, and some aboral plates at the tip of the arm are evident enough but are not at all conspicuous. It seems better to call these specimens *armatus* than to attempt to differentiate them as a distinct species. The specimen in the M. C. Z. from the Caroline Islands which I (1921, p. 82) referred to *armatus* is certainly not this species. It is too young for satisfactory identification but is probably *granifer* Ltk.

OPHIDIASTER CONFERTUS

Plate **10**, figs. 2, 3

H. L. CLARK, 1916. "Endeavour" Rep., p. 53.

This is certainly one of the characteristic reef animals at Lord Howe, even though it occurs also (so Mr. Livingstone tells me) on the New South Wales coast. It was the first sea-star that collecting on the South Reef flat near Mt. Lidgbird yielded and subsequent collecting showed it was common all over that extended area. It also occurred at Neds Beach, indicating that it is distributed all around the island. It lives more or less exposed among coral heads and rock fragments so it is quite conspicuous.

There are 25 specimens in the series at hand; they fall naturally into two groups of 6 young ones and 19 adults. The young ones have R = 10–23 mm. In the smallest, there is a single papula at each point where any four of the adambulacral, marginal and aboral plates meet each other; hence there are 8 longitudinal series of 9–11 very distinct single papulae along the arm. In the next larger specimen (R = 12 mm.) there are 2 papulae at each point, except basally, distally and orally; in a specimen with R = 13 mm., there are 3 papulae at some points. A specimen with R = 17 mm. is at this stage but the one with R = 23 mm. has 4–7 papulae in the aboral groups and 3 in those on the oral surface. In color, the young specimens under R = 20 mm. are very light, little pigment having developed but the one with R = 23 mm. is light orange brown.

The adults range from R = 58 to R = 155–160 mm. There is some diversity in the stoutness of the arms: one specimen has R = 97 and br = 12, hence R = 8 br, and the largest specimen has br = 18, hence R is about 8.5 br, but another specimen with R = 100 mm. or less has br 15 mm. or more, so that R is only about 6 br. It might be mentioned here that in very young specimens R = 4 br.

In coloration, *confertus* is never mottled or variegated, but unicolor, save for the tendency to a lighter tint on the oral side near the ambulacral furrow. Most individuals are a deep tawny yellow or orange brown, but some are lighter, ranging to a dull yellow orange; or darker, almost a real brown. In the dried specimens the range is from a rather dingy wood-brown to a very distinct (almost chrome) yellow. Alcoholic specimens are a light wood-brown.

HACELIA HELICOSTICHA

Ophidiaster helicostichus SLADEN, 1889. "Challenger" Ast., p. 405.
Hacelia helicosticha H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 111.

A very large example of this fine species, with R = 150–155 mm., is at hand, loaned by the Australian Museum. It is a perplexing specimen because the actinal papulae are poorly developed and only here and there at isolated spots can one count ten (or even nine!) longitudinal series of papulae. But the shape of the rays, associated with the additional actinolateral plates, leaves no doubt of the genus. The specimen bears only the label J69, but Mr. Livingstone tells me it is from northwestern Australia and was collected by Mr. F. J. Gibbons.

TAMARIA FUSCA

GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 283.

A single very young ophidiasterid is at hand from the Great Barrier Reef Expedition St. XVI, ½ mile west of North Direction Island, 20 fms., stony bottom. It has been identified by Livingstone as representing Gray's species and I see no reason for questioning the fact. It must be added however that ophidiasterids as small as this (R = 10–11 mm.) cannot be identified with certainty unless associated with a series of larger specimens.

TAMARIA MEGALOPLAX

Linckia megaloplax BELL, 1884. "Alert" Ech., p. 126.

The untangling of the snarl in which this species was enmeshed seems to have been accomplished satisfactorily by Livingstone, though I cannot accept all of his conclusions as to the synonymy. The growth changes in this species are more extraordinary than in any other sea-star, except perhaps Culcita or some of the multiradiate forms. Young individuals of *megaloplax*, having R less than 45 mm. are conspicuously prickly, most of the marginals and many aboral plates being capped with a pointed tubercle or spine. As growth proceeds, these tubercles are more and more resorbed. But the rate of resorption differs greatly in different individuals; in one specimen at hand from Broome, given me by Mr. R. A. Bourne, with R only 62 mm., the process is complete — not a tubercle is left; in another specimen, from the Lacepede Islands, given me by Colonel W. O. Mansbridge, with R = 70 mm. many tubercles on the aboral plates, and most of those on the marginals are still evident though greatly reduced; in an adult specimen, with R rather more than 100 mm., which we took at Broome in June, 1932, the tubercles are mostly resorbed but there are some still present on the inferomarginals.

Diversity in color is also rather considerable. Young specimens seem to be variegated light and dark browns, with the oral surface light. Adult specimens are very handsome — cream color orally and variegated aborally with pale gray and brown of at least two well-marked shades (See H. L. Clark, 1921, pl. 8, fig. 1, as *T. tuberifera*).

Besides the three specimens mentioned above a very small Ophidiasterid, with R = 12 mm., from Lindeman Island, sent by Mr. Ward, may possibly represent this species. It is obviously different from the young *fusca* listed above, as the skeletal plates each bear one or more large granules, which indicate that each plate will soon be provided with such a tubercle as characterizes *megaloplax*.

On one or two points, I have to differ from my friend and colleague, Livingstone, in regard to this species. He says (1932, June, p. 369) of the specimen with R = 58 mm., from Holothuria Bank, which he figures: "It is obviously the only specimen of *megaloplax* from Holothuria Bank handled by Bell." A specimen in the M. C. Z. received from the British Museum is one of Bell's original specimens and was labelled by Bell himself as "*Linckia megaloplax*." Livingstone has examined this specimen but says of it (1932, Feb., p. 260) that he thinks it should be referred to Koehler's species *hirsuta* and he figures it under that name. After long and careful examination of the available material and Livingstone's figures, I am convinced that *hirsuta* Koehler is based on a young specimen of *megaloplax*; or at least, specimens from northwestern Australia, which answer to Koehler's description and figures are undoubtedly to be referred to *megaloplax* and not to an Andaman Island species. The only known Andaman Island specimen, Koehler's type of *hirsuta*, is of course immature; it is possible that when adults are taken they will prove to be different from *megaloplax*. Meantime I include *hirsuta* in the synonymy of Bell's species.

TAMARIA TUMESCENS

Ophidiaster tumescens KOEHLER, 1910a. Abh. Senckenb. Nat. Ges., **33**, p. 277.
Tamaria tumescens H. L. CLARK, 1921. Torres Strait Ech., p. 94.
Tamaria propetumescens LIVINGSTONE, 1932, June, Rec. Austr. Mus., **18**, p. 369.

Among the dry sea-stars from the Lacepede Islands which Colonel Mansbridge so generously gave me at Broome in 1929 was a Tamaria, unlike any species known to me, but we failed to take any living specimens in all our collecting. In 1932, Mr. Bourne gave me a small specimen of the same thing, with all the arms more or less missing. On June 16, 1932 in Pender Bay, Wan, our diver, brought up a living individual and afterwards in our dredging, north and south of Roebuck Bay, we secured a number of specimens. In the Perth Museum, is a fine specimen from Broome, kindly loaned me by Mr. Glauert; it has R = 95 mm. but has lost all trace of its natural color and is now a light brown. In life, *tumescens* is a very lovely sea-star, bright old-rose color with the papular areas light gray brown and the sides of the ambulacral furrows yellowish.

This series of 15 specimens shows conclusively that Livingstone's *propetumescens* is but a form of Koehler's species; each was based on a single small specimen, half grown or less. The Broome Tamarias range from R = about 40 (the arm tips are missing) to R = 98 mm. In this large adult, r and br each = about 15 mm.; hence R = 6.5 r or br as in Livingstone's specimen; in the text Koehler gives R = 7.5–8 r but his figures indicate R about equals 6 r. The Broome specimens show little diversity R ranging from 6 to 7 r. There is more diversity in the presence or absence of spines on the inferomarginals and the extent of the adradial series of plates, while the arrangement of the aboral plates, especially on the disk, is very diversified. Usually inferomarginal spines are wanting and the adradial series are short, but the specimen from the Lacepede Islands has many spines and long adradial series, and a Broome specimen with R = 87 mm. has numerous inferomarginal spines, very irregularly distributed, and the adradial plates extend to the middle of the arm. So far as the present series shows there is no correlation between the presence of spines and the size of the specimen.

This is one of the most pleasing sea-stars in the Broome fauna, and dried specimens may retain more or less of their rose color for years provided they have never been in alcohol. It lives exposed on the sandy sea-bottom and like most ophidiasterids, it is very rigid and inert.

Pseudophidiaster rhysus

H. L. Clark, 1916. "Endeavour" Rep., p. 55.

Professor Bennett has sent a specimen of this sea-star taken Feb. 23, 1930, in the Great Australian Bight, by Mr. D. L. Serventy, on the trawler "Bonthorpe," in 90 fms., lat. 33° 15′ 0″ S., long. 126° 22′ 15″ E. According to Mr. Serventy's notes it was "dark purple" in life. It is now a dull gray, quite different from the fawn color of the types. It is a rather small specimen with R only about 100–110 mm.

ASTEROPIDAE

Petricia obesa

Plate **10**, fig. 1

H. L. Clark, 1923. Jour. Linn. Soc.: Zool., **35**, p. 241.

This remarkable sea-star is one of the most strikingly colored of echinoderms. When living it is brilliant scarlet with the small madreporite and the papulae almost black. The big interradial pedicellariae apparently close tightly when the animal is captured and being completely buried in the thick skin, do not show at all. On being dried, after killing in formalin and corrosive-sublimate, a large specimen (R = 70 mm.) kept its color very well and now, six years later, is a brilliant yellowish red. A smaller specimen (R = 54 mm.) is now a reddish yellow. The difference is apparently due to the much thinner skin in the smaller individual. A third specimen (R = 75 mm.) is an orange-brown, but this one was not preserved until several days after collection and then was placed in methylated spirits and subsequently dried. The largest and smallest specimen each have the 10 conspicuous interradial pedicellariae on the dorsal side, but the third specimen has only 9; none of these specimens show any other pedicellariae anywhere.

The largest specimen was taken at Bunkers Bay, in January, 1930, and was generously sent me by Professor Bennett. The other two were taken by Professor Bennett and myself at Point Peron, October 23, 1929. The larger one, lying on the bottom in 6–8 ft. of water, by its brilliant color attracted our attention from a low bluff overlooking some reefs and rocks a few yards from shore. Mr. Bennett kindly dove for it and presented it to me — permanent trophy of a never-to-be-forgotten day! Never having seen a living specimen of the eastern species, *vernicina*, and having handled but very few museum specimens, I do not know how important the differences between the two species really are. So far as present material is concerned, they are quite distinct.

ASTERINIDAE

Asterina anomala

H. L. Clark, 1921. Torres Strait Ech., p. 95.

It was a pleasant surprise to find this odd little sea-star, known hitherto only from a few specimens taken at Mer, at the northern end of the Barrier Reef, very common at Lord Howe Island. A series of 369 specimens is at hand, regarding which certain statistics may be of interest and possibly, value. As regards size, the species is always small, with R = 10–12.5 mm. at the most. As for form, it is rare indeed to find a symmetrical specimen, so persistently autotomous are these little sea-stars. One 4-rayed individual with R = 12.5 mm. seems to have attained stability as it is approximately symmetrical. Of individuals with more than 4 rays, not a perfectly symmetrical one has been noted though several approach it having two groups of equal rays; but the difference between the two groups is not hard to see. Normal mature rays are narrower and higher in life than in preserved material which tends to become quite flat. The number of rays ranges from 2 to 8, but curiously enough, excepting only 2, which of course indicates a fragmentary specimen, 5 is the least common number and is really very infrequent, while 7 is the most common and is found in a few more than half the 369. The average number of rays in the whole lot is almost exactly 7, if the 4 2-rayed fragments are omitted. One-fourth have 8 rays, but 10% have 6, 8% only 4, and almost 5% have only 3. Only 5 specimens are pentamerous and one of these has a ray split so that there are apparently 6 rays but only 5 jaws. As a rule a madreporite is wanting but one is not rarely found and two or three may be present. Truly the name *anomala* is appropriate for this Asterina.

In color, *anomala* is rather constant (See H. L. Clark, 1921, pl. 7, fig. 8) but some individuals are darker than others and a few show small deep red blotches aborally. At Cape Leveque, northwestern Australia, where two specimens were taken in August, 1929, the red was predominant, covering the disk and base of 4 normal rays; the median part of these rays was deep green and the margins were rusty, as were the 2 or 3 young rays growing out from one side. Preserved material ranges from pure white to a rather deep brown.

Like other Asterinas this species usually occurs on the under side of rock fragments and in hollows and crevices in dead coral or rock. But at Neds Beach, Lord Howe, on April 6, 1932, many were found in coralline algae on the upper surface of stones, clinging awkwardly among the branches, a habitat so ill-adapted for a flat sea-star like Asterina one suspects that only abnormal conditions of some sort led to it.

This little sea-star has a wide distribution on the coast of tropical Australia. It was originally taken at Mer at the northern end of the Barrier Reef; as it proves to be very common at Lord Howe, it is probable that it is to be found anywhere between those two points where local conditions permit, but of course its small size, protective coloring and secretive habits cause it to be easily overlooked. The 382 specimens in the present series are from the following points:

Lord Howe Island: April, 1932. 369 specimens, adult and young.
Australian Museum coll. 2 adults, 1 with 7, 1 with 8 rays.
Northern Territory: Darwin, dredged near Shell Island, 4–5 fms. 5 small adults, 1 with 4 rays, 3 with 7, 1 with 8. Color, variegated green and greenish-white, with no red or rust-color.
Western Australia: Cape Leveque, August, 1929. 2 small adults, 1 with 6, 1 with 7 rays.
Broome, August, 1929. 2 small 7-rayed adults so recently divided that only 3 or 4 arms are at all evident.
Broome, June 1932. 2 young specimens, 1 with 6, 1 with 7 rays.

ASTERINA BURTONII

GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 289.

It is rather remarkable that we met with this widespread East Indian and East African species but once and that was not until June, 1932, when a single small specimen (R = 11 mm.), bright orange-vermilion above and below was dredged near the entrance to Roebuck Bay in 5–8 fms. Its rays are long and narrow, both r and br equalling but 5 mm. Another specimen is at hand, loaned by the Western Australian Museum. It has R = 17 mm. and was taken at Bernier Island, Shark Bay, W. A. While somewhat stouter than the Broome specimen, it is not essentially different. The species has furthermore been recorded from the Abrolhos Islands (H. L. Clark, 1923, p. 243), so that the occurrence in Shark Bay is quite to be expected. The only other record for the Australian Coast which seems valid is that from the Murray Islands, at the northern end of the Great Barrier Reef (H. L. Clark, 1921, p. 96).

ASTERINA CORONATA FASCICULARIS

Plate 12, fig. 1

FISHER, 1918. Ann. Mag. Nat. Hist. (9), **2**, p. 110.

The discovery that this is the common sea-star of Darwin and the neighboring coast was one of the most interesting results of our collecting there in 1929. It was the first sea-star found and proved to be one of the very few echinoderms that occurred along the shore near town. Later collecting showed that it was of general occurrence along the coast but was most common at East Point. It seems to prefer very shallow water for all of the few specimens dredged were small. Tide pools left with little or no water at low tides were its favorite habitat. It lives, like other Asterinas, on the underside of rock fragments and hence wherever such fragments were exposed at low tide, *coronata* was a possible "find." While the number of rays is almost always 5, in the present series of 108 specimens, there are two with but 4 rays, two with 6 and one with 7. None of these specimens shows any trace of autotomy and it is evident that asexual reproduction does not normally occur in this species. The 4-rayed specimens are symmetrically tetramerous; in one R = 11 mm., in the other 23. The smaller 6-rayed individual is perfectly symmetrical with R = 12 mm. and no madreporite present, but the larger specimen is not symmetrical for while five rays are about 20 mm. long, the sixth is only 17, and there are 2 madreporites, each in an interradius, but not near the extra ray. The 7-rayed specimen is small and not noticeably unsymmetrical but R ranges from 8 to 9 mm. and when seen from the oral side, one ray is evidently shorter and narrower than the rest. Compared with a normal pentamerous specimen of similar size, the rays are rather wider and more rounded distally but the difference is not marked. There is only one madreporite and that is small and squarely in a radius.

In size, the present series ranges from R = 3.5 to R = 33 mm. The ratio of R to r is commonly about 2 to 1. In the 7-rayed specimen the ratio is only about 1.5 to 1 but in the larger 4-rayed individual it is 2.5 to 1. Of course the exact ratio is affected in the preparation of specimens; interradii shrink more in drying than do the radii; hence in most large pentamerous specimens R = 2.25r or thereabouts. Very young specimens of course have rather shorter rays with R about equal to 1.6r.

There is the greatest diversity in the number of elevated spiniferous aboral plates. In one specimen with R = 21 mm. there are no such plates conspicuous but on each ray several can be detected; they are however low and bear no large spinelets. A somewhat smaller specimen has 1–3 enlarged plates on each ray and on the disk, but they are small and low. At the other extreme is an individual with R = 25 mm. having 30–45 conspicuous, elevated, spiniferous plates on each ray. Most of the full grown specimens with R exceeding 30 mm. have 20–35 such plates on each ray but in one individual with R = 30 there are only 10–15. I am convinced that no specific or varietal character, on which reliance can be placed, is to be found in this noticeable feature taken by itself. The same is true as regards the oral and adambulacral spines; the number of adambulacral spines is typically 6–8, very commonly 7, but often 8 in full grown individuals; the oral spines are usually 8 on each plate but there may be as few as 6 and in some big individuals there are 9. As for the actinal intermediate spinelets there are commonly 4 or more on each plate, but occasionally a plate is seen with only 2 or 3; 2 is unusual, but 3 is not a rare number.

This large series of specimens, with the diversity it shows in spinulation naturally throws some light on the varieties proposed by Fisher (1919, p. 413). As I have seen nothing I can call pedicellariae, the variety *cuerces* is not affected by the Darwin material, which for the most part falls readily into variety *fascicularis*, as would be expected, since one of the types of that form is from Port Essington. But it seems clear that not much reliance can be placed on the number of adambulacral and oral spines, and certainly not on the number and conspicuousness of the enlarged aboral plates. The questions therefore arise whether the variety *cristata* can be maintained and whether it and *fascicularis* are sufficiently constant to warrant separating them from typical *coronata*. The one feature which seems to warrant such a grouping is found in the armature of the actinal intermediate plates. In the groups of 3 or more, often 5 or 6, spinelets found in *fascicularis*, we have a very evident difference from the 2 or 3 spinelets of *coronata* and *cristata*. Between these two latter forms, the difference in the enlarged aboral plates is striking, in the few specimens at hand, but it may be that a large series of Japanese specimens will show as much diversity in this particular as do the specimens from Darwin. The two specimens at hand from the Caroline Islands are alike in this feature but are rather distinctly unlike in the actinal intermediate spinelets; the type of *cristata* has 2, or often 3, rather short, blunt, diverging spinelets on each plate, while a somewhat smaller specimen has 3, rarely 2 or 4, longer, acute, clustered spinelets, much as in *fascicularis*. A specimen from Zanzibar is like the Japanese one on the aboral surface but orally is peculiar in that several actinal intermediate plates just back of the orals carry straight "combs" of 5 or 6 slender acute spines, which become groups of 4 or 3 on the more distal plates. In a somewhat larger Japanese specimen such a comb, with 6 spinelets, is present on a single plate in one area. As a result of all these comparisons, I am led to conclude that the varieties named by Fisher may well be recognized until abundant material from Japan, the Carolines, and the East Indies shows that their distinguishing features are not reliable. Should such material show as great constancy in the actinal spinulation as is shown by the Darwin material, it will not be surprising if *fascicularis* proves to be a valid species, characteristic of tropical Australia, perhaps confined to the coast of the Northern Territory. The probability is rather great that the Zanzibar form will ultimately prove to be distinct — at least as a recognizable variety.

It is curious that this sea-star should prove to be so common in the vicinity of Darwin and yet not be found at any great distance either east or west of that place. At Quail Island, about 35 miles to the west we found 7 specimens, agreeing in all details with those from East Point on the other side of Port Darwin. It was a great disappointment not to find even one specimen in Port Essington, a type locality, nor at any other point where we collected on the Coburg Peninsula. The species is not known from Torres Strait or on the Barrier Reef, nor has it yet been detected at any point on the coast of Western Australia.

The colors in life of this interesting little sea-star are attractive and somewhat varied, and the following extracts from my field notes are published, since preserved material undergoes great change. Alcoholic specimens become almost completely bleached to a dingy white, while dried material becomes either plain "museum color" or some shade quite foreign to the living tints. Several large specimens are now a dull blackish-brown aborally and one is very distinctly dull violet, a shade not noted in living specimens.

"The normal coloration is mottled olive-greens, light and dark, with more or less dark dull red, usually in irregular blotches. One specimen was very largely bright rust-red, over most of the dorsal surface," and retained this color well, for a time, after drying. "Most specimens lose the green shades on preservation becoming brown or gray." "Some specimens occur with no trace of green dorsally;

these are more or less fawn-color mottled with brown and have a distinct red tinge." "Most specimens have red markings but the shade may be very deep; in a few cases it was replaced with black. A common feature is a blotch of carmine at the base of each arm; in one specimen this was nearer vermilion." "Pigment is obviously very soluble in alcohol as the colors are dissolved out rapidly making the alcohol bright orange-red and leaving the specimens pale museum-color."

The 108 specimens of *fascicularis* at hand were taken as follows:

Northern Territory: Darwin, East Point, June and July, 1929. 87 specimens, adult and young.
Darwin, near Shell Islands, 3–6 fms., July, 1929. 5 specimens, young, 1 hexamerous.
Darwin, Talc Head, July, 1929. 2 specimens, adult and young.
Darwin, West Point, June, 1929. 4 specimens, adult and young.
Darwin, near laboratory, June 19, 1929. 2 specimens, young.
Darwin, near Leper Station, 3–5 fms., May 25, 1932. 1 specimen, young.
Quail Island, tide pools, July 7–9, 1929. 7 specimens, adult and young.

ASTERINA INOPINATA

LIVINGSTONE, 1933. Rec. Austral. Mus., **19**, p. 3.

This is a very well marked species, admirably described and figured by Livingstone; no reference is however made to color. In a letter, Livingstone says that "the color varies slightly. Sometimes the species is a uniform cream; sometimes blotched here and there with unevenly placed patches of dark green." I think these notes must be based on specimens in alcohol for Professor W. J. Dakin said that the large specimen which he gave me was collected by himself at Long Reef and was "blue and white" in life. The specimens which I took at the same place a few days later showed the diversity of coloration to which Mr. Livingstone refers, but the ground color was a real white, not cream color, and when any pigment was present, as was usually the case, it was distinctly bluish and not green; in some cases it was dusky but in others it was a definite, though rather dark, blue. Except for one individual from Tasmania, in the Australian Museum, all the known specimens of *inopinata* are from the coast of New South Wales, between the Tuggerah "Lakes" on the north and Shell Harbor on the south. On November 28, 1929, we had the good fortune to take 11 specimens, during low tide, from the under surface of rocks, on Long Reef. They ranged from 13 to 30 mm. in diameter, and the lesser radius was very nearly equal in life to the greater, but some individuals were very distinctly pentagonal, especially as soon as they had contracted. The blue and white coloration is so unusual that the species is unmistakable in life. The specimen given me by Dr. Dakin is the largest yet found as, even in its dried and somewhat contracted condition it is 35 mm. across; as even now R = 20 mm., the diameter in life was fully 40 mm. None of the specimens at hand are small enough to show the remarkable interradial slits described by Livingstone in very young individuals but some of the smallest specimens show a distinct interradial notch.

The 13 specimens of *inopinata* before me were taken at the following points:

New South Wales: Colloroy, Long Reef. W. J. Dakin leg. et don. 1 large adult.
Colloroy, Long Reef, November 29, 1929. 11 specimens, adult and young.
Shell Harbor. May 4, 1932. 1 small specimen.

ASTERINA SCOBINATA

LIVINGSTONE, 1933. Rec. Austral. Mus., **19**, p. 1.

When in Hobart in November, 1929. I was the recipient of many interesting echinoderms from Professor T. T. Flynn of the University and among them are 3 specimens of this interesting Asterina, so well described and figured by my Australian colleague. The smallest has R only about 7 mm. but it is not essentially different from the two larger specimens in which R = 14–15 mm. In one of these, the disk is notably high, the arms quite pointed and the color a gray-brown while in the other the whole aboral surface is somewhat flattened, the arms are much more rounded at the tips and the color is a very light yellow-brown. It is probable that these differences are wholly due to differences in preservation of the material. The small specimen was taken with the light-colored adult and is quite similar to it in form and tint. All 3 specimens show more or less clearly 5 pairs of remarkable, small, uncalcified spots on the actinal intermediate areas, which are apparently characteristic of the species, but their position and distinctness seem to admit of considerable diversity.

Evidently this sea-star occurs widely distributed on the Tasmanian coast for the gray-brown specimen was taken by Professor Flynn at "low tide, Wynyard," northwestern Tasmania, while the others bear the label "Eagle Hawk Neck, Tasmania" (which is on the southeastern coast), January 27, 1928. V Irwin Smith, collector.

With some hesitation, I also refer to this species, 2 Asterinas which I collected in the Derwent estuary at Hobart, on that notable November 15, 1929. My field notes made at the time read: "Asterina sp.? — 2 specimens — Deep brown above, cream-color below in sharp contrast. Under rocks at tide line, with *exigua* but obviously much rarer." Unfortunately the exigencies of collecting on that trip prevented careful preservation of these specimens; they are irregularly contracted and flattened, and the spinelets of the oral surface are relaxed and prostrate quite unlike the condition of the other specimens. Moreover the actinal non-calcified spots are very inconspicuous or wanting altogether in some areas and the aboral surface has the plates more numerous, more crescentic and more densely covered with minute spinelets. Hence these Hobart specimens have a different facies from the others and I have hesitated about their identification. But the more I have compared them with the other Tasmanian Asterinas in hand which seem to be *scobinata* without doubt, the more I am convinced they had best be called by the same name, as they fall within a moderate range of variation. In one specimen R = 13 mm. while the other is smaller; both have very broad rays (7–8 mm.) but this is in part, at least, due to their not very satisfactory preservation. Only further collecting can demonstrate whether their color in life as given above is characteristic of the species; they are now ordinary "museum color."

ASTERINA ALBA[1] sp. nov.

Plate 22, fig. 7

Rays 5. R = 9 mm., r = 4.5–5 mm. R not quite 2r. Form distinctly stellate with the interbrachial arcs rather acute. Aboral plates distinctly imbricated radially, much less so or not at all interradially; each plate carries 2 or more very minute spinelets, scarcely visible to the unaided eye; these spinelets are very short as well as slender and are usually in a single linear series of 2–7, but on a few of the larger plates, they may be in double series of about the same length; superomarginals squarish, with a central group of 3 or 4 of the very minute spinelets; inferomarginals, with projecting tufts of spinelets, form the ray margins as usual.

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[1] *albus* = white, in reference to the color in life.

Actinal intermediate plates relatively few; about 10 large ones, back of the oral plates, and 15 diagonal series (of 6 decreasing to 2) on each side of each ray; each large plate has 1 relatively stout spine (or sometimes 2) at its center while the remaining plates have usually 2 smaller spines. Adambulacral armature, a furrow series of 4 slender but blunt spines and a subambulacral series of 3 spines set obliquely on the plate; these may be subequal or the one nearest the furrow, or the middle one, distinctly largest, and bigger than any spine in the furrow series. Oral plates each with a marginal series of 7 or 8 close-set, slender spines, the innermost longest, and one large spine on the surface.

Color in life, almost pure white, but the larger individuals show, under a lens, traces of orange-yellow and a few scattered patches of dusky or purple, on the aboral surface. Specimens in alcohol are whitish, but dried specimens range from pure white to yellow-brown.

Holotype, M. C. Z. No. 3239 from under surface of a rock fragment, Neds Beach, Lord Howe Island, April, 1932.

There are 69 paratypes, chiefly from Neds Beach and the southern reef-flat near Mt. Lidgbird, but several were found on the reef north of Goat Island. They occurred with *anomala* but were always easily distinguished by the color and the pentamerous symmetry. They range in size from R = 2.5 mm. up to the holotype, which is much the largest specimen taken. One specimen, 10 mm. across, is hexamerous but, although not perfectly symmetrical, shows no evidence of autotomy. All the larger specimens show, under the lens, one or more non-calcified spots in the actinal intermediate areas, similar to those of *A. scobinata*. But in the Lord Howe species, these spots show great diversity in number and position, and are always very minute; in the holotype there seem to be a pair well separated from each other in each area some distance back of the oral plates, but in other specimens, they are wanting in one or more of the areas, often in all but one, and their position differs in different areas; sometimes 3 occur in one area, one or two of which are near the adambulacral plates. In most of the small specimens, these curious areas seem to be lacking. It is unlikely that their presence has any definite significance.

This species is easily distinguished by its regular pentamerous but markedly radiate form, the absence of spinelets of any considerable size on the aboral surface, the adambulacral armature, and particularly by the single large spinelet on the surface of each oral plate.

Asterina heteractis[1] sp. nov.

Plate 22, fig. 5

Rays 7, narrow, high, relatively long and well separated. $R = 7$ mm., $r = 4$ mm., $R = 1.75r$. Disk flat. Aboral plates, of irregular shape and only imperfectly imbricated. Each plate carries a small tuft of 3 or 4 low blunt spines, not at all thorny. Papulae relatively large, in 4 series on the basal half of each arm. Inferomarginal plates fairly conspicuous, each with a horizontal comb of 4–7 relatively long spinelets which may be a little thorny near tip. Madreporite exceedingly small with only 6–8 pores, at the base of a ray on one side of the median line.

Actinal intermediate plates few in 3 series on each side of each ambulacral furrow; only the innermost extends to the tip of the arm while the outermost is very short. Each plate carries 1–3 (usually 2) short, sharp spinelets; when 2 or 3 are present one is often distinctly larger than its fellow (or fellows). Adambulacral armature in 2 series as usual; on the furrow margin is a group of 3 (or 4) short, blunt, relatively large spinelets and on the surface of the plate is a similar but somewhat smaller trio set at an angle to the furrow series. Oral plates small, each with 4 relatively large opaque marginal spines, the innermost not very much larger than the outer ones; on the surface of each plate is a similar spine (or sometimes 2).

Color in life, uniform salmon pink above, whitish below, with no indication of green or red anywhere; the dry specimen is almost uniformly yellowish-white.

Holotype, M. C. Z. no. 3258, from the under surface of a rock fragment on sand above low water mark at Neds Beach, Lord Howe Island, April, 1932. Collected and donated by Miss Karna Birmingham.

Besides the holotype, there are 3 other Asterinas from Lord Howe which belong to this species. One is a small, nearly white, 6-rayed specimen found on the under side of a rock fragment; as 3 rays have $R = 4$–5 mm. and the opposite 3 have R about 2 mm., it is evident that autotomy has taken place. The other 2 specimens were dredged in the lagoon near Goat Island; they showed no trace of green or red but were uniformly light orange-colored in life; that tint however was lost as soon as they were dried and they are now very pale brown or nearly white. Each has but 3 arms (R = 7 mm.) and is obviously the result of autotomy so recent that the growth of the new arms has not yet begun.

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[1] *ἕτερος = other than usual* + *ἀκτίς = a ray*, in reference to the number of arms.

That this little Asterina is closely related to *anomala* is evident, but it is apparently quite distinct. The most obvious difference is in the spinulation of the aboral plates; in *anomala* the spinelets are much more numerous, somewhat glassy and thorny at the tip; while in *heteractis* they are few, opaque and rather blunt without thorns. On the actinal plates of *anomala* are 3–5 thorny spinelets, while in *heteractis*, the spinelets are fewer and not thorny. Both on the adambulacral and oral plates there are more and larger spines in *anomala* than in *heteractis*, even in specimens of the same size. How much weight may be given to the marked difference in the form of the rays and in coloration, only much more material of *heteractis* can determine.

ASTERINA LUTEA[1] sp. nov.

Plate 12, fig. 2

Rays 5, broad and rounded, the interbrachial areas only slightly concave with a distinct notch in the interradial line. R = 20 mm., r = 16 mm. R = 1.25r. Disk moderately elevated, the vertical diameter being about 6 mm. Aboral surface covered with numerous imbricated plates, largest in the proximal interradii and least imbricated distally in the same areas; there are about 15–17 longitudinal series of plates covering each radius, with the papulae conspicuous between them; the large papular areas on each ray are rounded diamond-shape, 15–16 mm. long and 11–12 mm. wide. Aboral plates with more or lesss evident series of minute spinelets which curve about the lower or distal side of each papula; on the interradial and lateral plates where there are no pores, these curved series of spinelets are reduced to minute tufts which disappear entirely on the insignificant superomarginal plates. Margin of body formed as usual in Asterina by inferomarginals which carry tufts of numerous, relatively long but exceedingly slender spinelets. Madreporic plate small, triangular, only 3 mm. from anus.

Actinal intermediate areas with numerous plates arranged in about 10 series parallel to the ambulacral furrow; those adjoining the furrow are largest and 3 or 4 extend to the tip of the arm; the outer series become smaller and shorter until the outermost is made up of only 3 or 4 plates. Each plate carries a group of spinelets, slender and sharp; on the larger plates, they form a very definite line or comb of 5–7, the middle ones distinctly longest, the outermost shortest; on the small plates near the inferomarginals the spinelets form a minute tuft of 3 or 4. Adambulacral armature in two fanlike series of relatively long and very slender spines; the furrow series is made up of 7 (rarely 8) spines, while the subambulacral series contains 6 slightly swollen ones; the two series are remarkably alike save for the evident, though slight difference in size. Oral plates conspicuous, the inner margin of each being elevated to form an evident ridge; marginal spines 9, long and slender, the innermost large and relatively stout, about half as large again as the distal ones which are similar to those of the furrow series. A slightly curved transverse series of 4 or 5 small spines occurs near the middle of each oral plate and distal to this is an insignificant group of 2 or 4 minute spinelets.

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[1] *luteus* = orange-colored, in reference to the color in life.

Color in life bright orange-vermilion, quite uniform over both upper and lower surfaces. Sometimes the color is not so bright and might be called dull yellow. In one case the orange was obscured by a grayish tint except around the margins, but when this specimen was dried it became as orange as the others. Individuals under 10 mm. in diameter have little or no pigment but are nearly or quite white; the color however develops rapidly after that. On preservation, either in alcohol or by drying, the orange color is retained for a longer or shorter time but ultimately it disappears and the specimens become nearly white in alcohol or, if dried without immersion in alcohol, "museum color" of a lighter or darker shade; often the radial areas, in dry material, are distinctly dusky, unlike the interradii and margins; in other cases, the margin is distinctly lighter than the disk and basal portion of the rays; in one specimen the latter area is still quite definitely orange.

Holotype, M. C. Z. no. 3261, from under surface of a rock, near low water mark, Entrance Point, Broome, August, 1929.

This was a relatively common sea-star near low water mark at Entrance and Gantheaume Points, Broome. We also took it at Barred Creek to the north of Roebuck Bay and Captain Bardwell found one specimen at the Champagay Islands or Augustus Island. It lives like other Asterinas on the under surface of rock fragments but its bright color makes it more conspicuous than most members of the genus. It belongs in the same section of Asterina with *nuda* H. L. C. from the Murray Islands and *orthodon* Fisher from Hong Kong. While obviously near these two species, it is recognizable by certain distinctive features.

Compared with the type of *nuda*, the present species differs markedly in color in life, has smaller and more numerous skeletal plates, most noticeable in the aboral interradii and the actinal interradial areas, and the aboral plates are far more spiniferous and not at all smooth and shining. Compared with *orthodon*, the Western Australian form may be distinguished by the adambulacral and oral armature; the form and proportions of the furrow series, and the marginal series on the oral plates is markedly different in the two species. Mortensen (1934, p. 9) says that the specimen of *orthodon* which he studied was of a "light pink colour, when received" which indicates a marked difference in color in life from *lutea*.

There are 55 specimens of *lutea* at hand ranging in size from young ones with R = 5–6 mm. up to a very large individual with R = 26 mm. and r = 20. The ratio of R to r shows considerable range in the preserved specimens, from R = 1.15r to R = 1.4r. In life however there is less diversity, as the form is quite pentagonal with the sides usually a trifle concave or distinctly convex. Autotomy apparently never occurs and non-pentamerous variants are rare. There is one perfectly tetramerous young individual, a square with 4 equal sides about 8 mm. long. Another young individual, about 15 mm. across is perfectly hexamerous with nearly straight sides, while an adult just twice as large (R = 15 mm.) is also perfectly hexamerous, but its sides are deeply concave (r = 10–11 mm.).

ASTERINA PERPLEXA[1] sp. nov.

Plate 22, fig. 4

Rays 5, with form distinctly stellate. R = 14 mm., r = 10 mm., R = 1.4r. Disk about 5 mm. in vertical diameter. Aboral plating as usual but coarse; there are only 16–18 plates in the carinal series from center of disk to terminal plate; each plate carries a short comb or small tuft of minute sharp spinelets but many of these have been knocked off in handling the dry specimen. Papulae numerous and very large, the perforations in the aboral skeleton being .30–.40 mm. in diameter. Margin of inferomarginal plates very conspicuous with long tufts of very slender spinelets. Madreporite very small, not much more than 2 mm. from anus.

Actinal intermediate areas with relatively few and rather large plates, each of which bears a pair of long and very slender, acute spines, longer as a rule than the diameter of the plate. Adambulacral armature in the usual two series; the furrow series with 4 (or sometimes 5) long very slender spines, the subambulacral series with 4 (or 3) equally long spines. Oral plates with rather conspicuous median ridge on each side of which are 4 long and slender spines; the marginal spines 7–9, slender and delicate, the innermost not specially enlarged.

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[1] *perplexus* = puzzling, in reference to the resemblance to two or more quite diverse species.

Color in life, "distinctly white but with indefinite orange-yellow areas aborally; orally pure white." The dry specimen is very pale brown, lightest on distal part of rays and along margin, decidedly darker and more dusky on disk and basal part of rays.

Holotype, M. C. Z. no. 3266, found clinging closely to under side of a rock fragment at Neds Beach, Lord Howe Island, April 6, 1932.

When taken this individual was supposed to be the adult of *A. alba* and even now the aboral surface is strongly suggestive of the same thing. But orally the differences are so great a single glance is sufficient to prove they are not closely related. On the other hand, the resemblance to *inopinata* is great, particularly on the oral surface, but the more stellate form, the huge papulae, the long, slender actinal spinelets, and the color in life offer great obstacles to a close relationship. Again comparison with *lutea* suggest an alliance but after all this is probably superficial and not real. It is unfortunate that no other specimens were found; probably the normal habitat of the species is in somewhat deeper water than is accessible for collecting without a dredge, and where the nature of the bottom precludes the use of that invaluable aid.

DISASTERINA SPINULIFERA[1] sp. nov.

Plate 22, fig. 6

Rays 5, relatively narrow and high, but the strong contraction of dorsal muscles is evident and has led to the distal part of the arms being recurved; it is hard to say how much this contraction has altered the normal form. R = 7–8 mm., r = about 4; hence R is nearly or quite 2r; arms taper but little, br at base is 4 mm. and near tip it is fully 3; height of arm at base, fully 3 mm. Aboral plates numerous, very crowded, bare; on basal portion of arms, they are strongly imbricated but this is certainly due in part to the contraction already mentioned; distally and along the sides of the arms, the imbrication is much less marked and probably wanting in a normally contracted specimen. If there is any skin or membrane over the aboral plates in life, it has disappeared in drying; nearly all the plates are perfectly bare, but low down in each interradial area, above the marginal series, there are half a dozen or more which carry one or more long exceedingly slender spinelets, easily overlooked without a lens; near the madreporite are 2 or 3 plates which bear similar but much shorter spinelets. Papulae apparently few and irregularly scattered, not conspicuous. Superomarginal plates rather large in a fairly distinct series, but the inferomarginals form the actual margin of the body; they are small, project but little, and carry a linear series of numerous, minute spinelets which are long and slender on the proximal plates but become very short near the tip of the arms. Madreporite small but easily seen.

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[1] *spinuliferus* = bearing little spines, in reference to the very slender spinelets on some aboral plates.

Actinal intermediate plates as usual in the genus, small, each with a single large sacculate spinelet, and forming 5 or 6 parallel series along each side of the ambulacral furrow; several of the series extend to the tip of the ray. Just back of the oral plates, the non-calcified area characteristic of the genus is evident, its distal boundary being sharply defined by a single large plate.

Adambulacral armature made up of a furrow series of 3 or 4 slender spinelets and a large subambulacral spine. Oral plates each with a large spine on the surface and a marginal series of 4 slender acute spinelets not much larger than those of the furrow series on the adambulacrals. Color in life not noted; dried, it is a dingy white.

Holotype, M. C. Z. no. 3267, from Broome, northwestern Australia, June, 1932.

This little sea-star was probably dredged in 5–8 fms. of water. Unfortunately its characteristics were not conspicuous enough to attract attention when collected, and it was only when the Asterinas from Broome were being critically studied several years later that its unique character was detected. The genus Disasterina has been carefully reviewed by Livingstone (1933, pp. 5–11) who recognizes 3 species, all occurring on the Barrier Reef or the neighboring Queensland coast. The present species is readily distinguished by the character of the aboral surface, especially the spiniferous plates in the interradii.

MANASTERINA[1] gen. nov.

Similar to Disasterina, but with the aboral skeleton less rigid, the plates on the basal part of the rays lightly or not at all in contact; many plates carry a single minute spinelet; near the tips of the arms, the plates form 7–9 longitudinal series and many of them carry long slender spines; actinal intermediate areas without a non-calcified spot back of the oral plates, though the actinal plates themselves in that region are not very closely in contact (in the dry specimen).

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[1] *μανὸς* = *loose, flaccid,* + Asterina, in reference to the lack of rigidity in the aboral skeleton.

Genotype, *manasterina longispina* sp. nov.

As at present understood, Disasterina is a homogeneous group of four small species, so it seems better to make the present larger aberrant form the type of a new genus rather than to stretch the boundaries of the older one to include it.

MANASTERINA LONGISPINA[1] sp. nov.

Plate **21**, figs. 1–2

Rays 5, form markedly stellate, with moderately deep but rounded interbrachial arcs. R = 24 mm., r = 12 mm., hence R = 2r. Arms 12 mm. wide at base and 5 mm. close to the bluntly pointed tip. Aboral plates very numerous, irregularly rounded, lightly convex, of very diverse form and size; except for 2 or 3 near the madreporite, none are as much as a millimeter in diameter; on the distal half of the arms, the plates are closely in contact in 7–9 distinct longitudinal series but proximally (except near the margin and in the interradii) these become confused and the plates themselves are not completely in contact so that naked skin shows between them often; many plates overlap others at one point or another but there is scarcely any real imbrication. Many plates are perfectly bare but a considerable number have near the center a single minute spinelet and near the madreporite, which is distinct though not large, are several plates with 2–5 spinelets each. Near the tips of the arms, the spinelets become conspicuously elongated and may exceed a millimeter in length. Superomarginal plates small, forming an inconspicuous series but inferomarginals very conspicuous, each bearing a tuft of 2–4 very slender spinelets, 1.5–2 mm. long; this marginal fringe is very noticeable particularly on the distal half of the arms. Papulae apparently few and irregularly scattered; they are not easily detected in the dry specimen.

Actinal intermediate areas relatively small, with 8 or 9 series of plates back of the orals but only 4 (or 3) extend to the arm-tips; each plate carries one long, slender, acute, sacculate spine, which lies pointing outward to the margin; back of the oral plates there are indications that the plates are not in close contact but there is no non-calcified area such as is found in Disasterina. Adambulacral plates with a furrow series of 4 (distally, 3) slender spines, the median pair commonly much longer than the other two; a single large subambulacral spine is present on each plate, resembling closely the actinal spines but somewhat larger; the subambulacral spines of the most proximal adambulacral plates are the largest spines on the sea-star and measure as much as 2 mm. in length. Oral plates with a single big spine on the surface, just like the subambulacrals, and a marginal fringe of 5 spines, of which the innermost is longest, the next is a little smaller and the 3 outer ones are much smaller.

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[1] *longispina* = having long spines, in reference to the notably long spines of the marginal and actinal plates.

Color in life, aborally "reddish-pink" and orally "pale lemon yellow." The dry specimen is nearly white below, light yellowish-brown (museum color) above on disk and bases of arms; dull pinkish on distal part of arms and marginal fringe; where skin shows between plates it is nearly black.

Holotype, M. C. Z. no. 3268, from Rottnest Island, Western Australia, 1934, Captain Beresford E. Bardwell leg. et don.

Captain Bardwell wrote me in regard to this remarkable sea-star that "it was very soft and fleshy when found" and "about 3½ inches" across. As it is now less than 2 inches across, the shrinkage in drying has been extraordinary, quite in keeping with the statement that it was very soft and fleshy. It was living "attached to a flat sandstone rock" "on pure sand bottom." No other specimen was seen.

This is one of Captain Bardwell's most interesting discoveries among echinoderms, and were I not so strongly averse to mingling emotion with science, it would surely bear his name. As it is I can only express here again my very great appreciation of his work as a collector and my sincere gratitude for his generous help. There is no danger of confusing this sea-star with any previously known.

PARANEPANTHIA GRANDIS

Nepanthia grandis H. L. CLARK, 1928. Rec. S. Austr. Mus., **3**, p. 393.
Asterinopsis grandis LIVINGSTONE, 1933. Rec. Austr. Mus., **19**, p. 15.

The discovery that this species ranges to the coast of Western Australia was one of the surprises of collecting at Point Peron in October, 1929. A very large individual was found there on the under side of a rock fragment near low-water mark. It was closely appressed to the rock and owing to its dull fawn-color might have been easily overlooked. It underwent little change of color in drying, or subsequently, but it shrank fully 10% in size; even so it is the largest specimen yet recorded as R = 60–65 mm. and r = 28. We met with no other specimens but in January, 1930, Professor E. W. Bennett found 2 individuals at Bunkers Bay, immediately east of Cape Naturaliste, which he has generously sent to me. One of these, found in "drift on sand beach," is the smallest specimen yet recorded as R = only 7 mm. The other is a small and typical adult with R = about 35 mm. Both of these Bunkers Bay specimens are a light grayish-brown, quite different in appearance from the brighter yellow brown of the large individual from Point Péron.

Livingstone's (1933, p. 15) transfer of my *Nepanthia grandis* to Asterinopsis Verrill (1913, p. 480) was quite justified, but unfortunately Verrill's genus is a heterogeneous group, for which he selected as type one of Lamarck's species, *penicillaris*. Mortensen (1933, p. 258) has recently pointed out that this name probably lacks validity in which case Asterinopsis must also be invalid. However this may be, Verrill included in his genus both West Indian and Australian forms which are certainly not congeneric. As a beginning therefore in clearing up the confusion, I suggest that the Australian and certain East Indian species be segregated under the name Paranepanthia Fisher.

The large individual of *grandis* taken at Point Peron seemed so similar to the figure of Fisher's type of *platydisca*, that it was only by careful comparison of the specimens themselves, the essential differences could be determined. The most important of these are obviously the very much shorter paxillar spinelets and the smaller and far more numerous aboral plates of *platydisca*. The spinelets in *grandis* are nearly 3 times as long as in *platydisca* and make a correspondingly more conspicuous tuft. Moreover in the Philippine species in a series of aboral plates reaching the margin at middle of interbrachium, about 26 or 27 plates are present, while at the middle of ray about 17 or 18 can be counted; in the specimen of *grandis* however which is considerably larger than Fisher's unique type, only 22 or 23 plates are present in the interradial series and only 12–14 at middle of arm. There are similar differences in the adambulacral and oral armature in the two species for *grandis* is a coarser, higher and heavier sea-star than the Philippine form. The madreporite in *platydisca* is nearly triangular, sharply defined, with well marked furrows on its surface, whereas in *grandis* the madreporite is ill-defined and not easy to detect. There can be no doubt that the two species are quite distinct.

Livingstone (1933, p. 16) has already expressed his opinion that *grandis* is a Paranepanthia but could not see any satisfactory distinction between that genus and Asterinopsis — a name which must, as already pointed out, be abandoned. Besides *platydisca* and *grandis*, I should include in Paranepanthia, *brachiata* (Koehler) as Fisher suggests, *pedicellaris* Fisher and the two following species.

PARANEPANTHIA PRAETERMISSA

Asterinopsis praetermissa LIVINGSTONE, 1933. Rec. Austr. Mus., **19**, p. 14.

While collecting at Bottle and Glass Rocks, in Port Jackson, in November, 1929, with Mr. Melbourne Ward, two specimens of this interesting sea-star, so recently described by Livingstone, were found. While the relationship with *grandis* is obvious, the flatter disk, wider and more rounded rays and very much smaller and more numerous aboral plates distinguish *praetermissa* easily. The larger of the 2 specimens at hand has R = 32 mm. while the smaller one is about one-third as large (R = 11 mm.).

PARANEPANTHIA ROSEA[1] sp. nov.

Plate **22**, fig. 8

Rays 5, form markedly stellate, rather flat. R = 7 mm., r = 5 mm., hence R = 1.4r; br = 4–4.5 mm. Aboral plates of rather uniform size, in regular longitudinal series on the arms, the 3 median series rather distinctly set out from the rest; imbrication of plates not very conspicuous but evident along the middle and upper series of plates on the rays. Each plate bears a group of numerous, minute, diverging, glassy spinelets which cover its surface completely. Papulae rather numerous and more or less conspicuous (according to size and condition of specimen); usually 6 rows are evident on the basal part of each ray but the distance to which they extend distally shows considerable diversity. Superomarginals, 2 or 3 times as large, forming the margin of the animal; each one is well covered by the large number of minute spinelets which it bears. Madreporite small (.60–.70 mm. across) but distinct, only about 1.5 mm. from center of disk.

Actinal intermediate plates in longitudinal series parallel to adambulacral furrow; only the one adjoining the furrow extends to the arm-tip; the others fall short by increasing distances until the sixth or seventh consists of only 2 or 3 minute plates near the interradial line; each plate is fully covered by a rather dense cluster of minute spinelets like those on the aboral plates but obviously longer. Adambulacral armature made up of a furrow series of 6 (rarely 7) slender spines of which the median are longest, the outermost on each side, smallest; on the surface of the plate is a cluster of 8 or more very slender spines intermediate in size between those of the furrow series and the spinelets of the actinal plates. Oral plates rather small but with a conspicuous marginal series of 7 spines (the innermost largest) on each plate; on its surface is a cluster of 6–8 much smaller spines similar in size and appearance to the subambulacrals.

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[1] *rosea*, in reference to the pretty pink color, often retained in dry specimens.

Color in life rose-red, more or less variegated with cream-color; often the rose-red is little interrupted but in some cases, the cream-color predominates quite markedly; oral surface is always cream color. Dry specimens range (according to methods of preservation) from the natural rose-red to ordinary "museum color" or to nearly white.

Holotype, M. C. Z. no. 3272, from the cove on the northeast corner of Rottnest Island, Western Australia, October 19, 1929.

This pretty little sea-star, so different from any of the other Asterinidae of the west coast, is common at Rottnest Island and it was also found at Point Peron. It lives closely attached to the underside of rock fragments in shallow water. Of the 13 specimens which we collected at Rottnest, the smallest is hardly 9 mm. across while the largest have R nearly 8 mm.; of these one has 6 rays but there is no indication of autotomy; a smaller specimen ($R = 5.5$ mm.) apparently has only 4 rays but on the oral surface a minute fifth ray is evident. Besides the material which we collected, there are at hand 9 specimens which were taken at Rottnest by Captain B. E. Bardwell in 1934, 2 collected by Mr. G. Bourne at the same island in 1931 and 7 also from Rottnest, loaned by the Western Australian Museum. The pair collected by Mr. Bourne are hexamerous — probably they are selected specimens, preserved because they are 6-armed; one is full grown ($R = 8$ mm.), the other is much smaller ($R = 5.5$ mm.). Adult pentamerous specimens show considerable diversity in form due to differences in length of the minor radius and the breadth of arm; thus a specimen in the Western Australian Museum with $R = 8$ mm. has r and br 5.5–6 mm. while one of those taken by Captain Bardwell having $R = 8$ mm. has r and br 4.5–5 mm. and hence appears much more stellate. There is no Asterinid, of which I know, with which this species can be confused. Although much smaller than the other species of Paranepanthia, the resemblance to young specimens of *grandis* is so obvious, there seems no doubt that *rosea* is congeneric with that species.

Patiriella calcar

Asterias calcar Lamarck, 1816. Anim. s. Vert., **2**, p. 557.
Patiriella calcar Verrill, 1913. Amer. Jour. Sci., **35**, p. 484.

This fine and very distinctive sea-star was met with several times on the coast of New South Wales, but the finest specimen secured was taken at Hobart, Tasmania, November 15, 1929, where it was found above low tide mark but under water, exposed on the surface of a rock in a sheltered nook. It was nearly four inches across (R = 45 mm. in the dry specimen) and the color was "bright orange, with disk and interradial areas variegated with greenish and brown; central part of disk cream white with a brown spot at very center; lower surface cream-color."

Of 3 specimens which we took at Long Reef, Colloroy, November 28, 1929, the smallest (R = 20 mm.) has 9 equal rays, and of 3 small individuals found at Gunnamatta Bay on November 26, one, with R = 15 mm., has but 7 rays. We found a small specimen on November 27, at Bottle and Glass Rocks, Port Jackson, which has 8 rays but one is distinctly shorter than the other 7.

Mr. W. Heron of Coffs Harbor, N. S. W., kindly gave us in May, 1932, 34 small specimens of *calcar* from that vicinity, 2 of which have 9 rays and 1 has 7. These Coffs Harbor specimens have the rays more slender and attenuate than any of those from further south, but this might be associated with the method of killing and drying.

Patiriella exigua

Asterias exigua Lamarck, 1816. Anim. s. Vert., **2**, p. 554.
Patiriella exigua Verrill, 1913. Amer. Jour. Sci., **35**, p. 484.

This little sea-star is very abundant on the main coral reef on the western side of Lord Howe Island, particularly at the northern end and even more so at the southern end where it adjoins Mt. Lidgbird. We also found it common at Gunnamatta Bay, N. S. W. and at Hobart, Tasmania. A single specimen was secured at Long Reef, Colloroy, N. S. W. but probably it is also abundant there at suitable times. Altogether there are 2022 specimens at hand, of which 1959 are from Lord Howe.

The 32 specimens from Gunnamatta Bay are all pentamerous and small, the largest less than 20 mm. across. The 30 specimens from Hobart are a little larger, several being 21–23 mm. across, and one is perfectly tetramerous, with sides 16 mm. long; this last was a gift from Professor T. T. Flynn. The Hobart specimens were found on the under side of rocks above low water mark, as is usually the case. The color was "varied green or brown above with more or less red, never much; greenish or greenish-blue below." The notable harmony with the background has been well emphasized by Mortensen (1933, p. 253) as seen by him in South Africa.

At Lord Howe Island, this sea-star is so abundant, large collections were made at the two extremes of the reef to see if any local differences existed in the proportion of specimens having more or fewer than 5 rays. The distribution of *exigua* at Lord Howe is peculiar; not a single specimen was found on the eastern side of the island, not even at Neds Beach, where conditions for collecting echinoderms are the best of any one area on the island shore; on the western coast, *exigua* proved to be abundant on that coral reef area, abutting on Phillip Point, which shuts in North Bay, and also at the extreme southern end of the main reef where it abuts on Mt. Lidgbird. In the latter area, it was most abundant near high water mark on the rocks along shore. This peculiar distribution leads me to believe that *exigua* is a recent arrival at Lord Howe having been brought over from Port Jackson on foul ship bottoms. The *exiguas* living at North Bay were prevailingly light buff and greenish but often were variegated with shades of green and lacked the buff. Those on the south reef were distinctly darker, variegated light and dark green often with some orange; one specimen was predominantly orange. In both regions, the sea-stars were found on the under surface of rocks between tide-marks, but along the shore near Mt. Lidgbird they were almost equally common on the exposed surfaces of the rocks.

In 1913, I found *exigua* very common at Erub, an island in Torres Strait (see H. L. Clark, 1921, p. 97) and examined nearly 600 specimens to learn the percentage of non-pentamerous variants; the result showed that 92% were pentamerous, 6% were hexamerous, 1.5% were tetramerous and 3 specimens had 7 rays. Conditions at Erub were very favorable apparently and the sea-stars grew to a large size, the largest 35 mm. across, as compared with a maximum of 25 mm. at Lord Howe. (A specimen loaned by the Australian Museum is 28 mm. across). It occurred to me at Lord Howe, that comparison with the data from Erub would be interesting, so 800 specimens of *exigua* were collected at North Bay and 1100 along the shore near Mt. Lidgbird. The result is interesting but not extraordinary. At North Bay, 2.5% of the specimens were non-pentamerous, 2% (17 specimens) being hexamerous and .5% (4 specimens), tetramerous. At the southern end of the reef, a trifle more than 2% are non-pentamerous, exactly one in a hundred being hexamerous; 1 specimen has 7 rays, 5 have 5.5 (i.e. one ambulacral furrow is forked at a greater or lesser distance from the mouth) and 6 have but 4 rays. It is odd that there are twice as many hexamerous individuals at North Bay as at the southern reef flat but the numbers involved are too small to make the apparent fact significant. The difference between the Lord Howe population as a whole however, and that at Erub is perhaps striking enough to be important. Evidently variation is much more general at Erub than at Lord Howe, both 6 and 7 rayed specimens being much more common at the northern island. This might perhaps be reasonably construed as evidence that the Lord Howe population is younger and living under less favorable conditions and therefore variants are promptly eliminated; thus supporting the view that it has been introduced from Port Jackson in the past century.

PATIRIELLA GUNNII

Asterina gunnii GRAY, 1840. Ann. Mag. Nat. Hist., **6**, p. 289.
Patiriella gunii VERRILL, 1913. Amer. Jour. Sci., **35**, p. 484.

A large series of this characteristic Australian sea-star is at hand consisting of 375 specimens, ranging in diameter from 3 mm. to 75. Of the 375, 90% (342) have 6 rays, 5% (19) have 7 rays, while 8 specimens have 8 rays and 6 specimens have but 5. The color in life shows extraordinary diversity. The 385 specimens come from the following places:

Western Australia: Dongarra, E. W. Bennett leg. et don. 4 very young specimens.
Garden Island, near Fremantle, October 14, 1929. 1 small adult.
Rottnest Island, Point Vlaming, February, 1930, Swan and Drummond leg. E. W. Bennett don. 1 very small 7 rayed specimen, 3 mm. across. Found on seaweed.
Rottnest Island, October, 1929. 1 very small specimen.
Rottnest Island, 1934. Captain B. E. Bardwell leg. et don. 10 specimens.
Point Peron, October, 1929. 108 specimens.
Bunbury, October 26, 1929. 6 specimens.
Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 174 specimens of all sizes.

Ellenbrook Beach, January, 1930. E. W. Bennett leg. et don. 5 specimens.
Hamelin Bay, January, 1930. E. W. Bennett leg. et don. 4 specimens.
Exact locality, date and collector uncertain but undoubtedly collected between Point Péron and Hamelin Bay. 51 specimens, adult and young.
South Australia: Port Willunga, November 2, 1929. 1 small adult.
New South Wales: Locality ? Mr. S. Larnach leg. et don. 2 young specimens.
Colloroy, Long Reef, November 28, 1929. 7 adults.

PATIRIELLA BREVISPINA[1] sp. nov.

Plate 22, figs. 2–3

Similar to *gunnii* aborally, though the granules on the plates seem a trifle lower and more angular when dry specimens are compared side by side. On the oral surface all spines shorter and stouter than in typical *gunnii* and there are generally fewer to a plate. Actinal intermediate plates with very short spines, shorter than the plate that carries them and often not twice as long as wide; on most of the plates there are two such stumpy spines but near the oral plates, there is only a single spine to a plate and the large plates immediately distal to the orals may have none. Adambulacral plates with a furrow series of 2 short, flattened, truncate spines, much stouter basally than at tip; on the first 2 or more plates there are 3 such spines and in large specimens (R = 40 mm. or more) as many as 6 or 8 proximal adambulacrals have 3 spines; on the surface of each plate is a single stout subambulacral spine, often wider at tip than at base and only 2–4 times as long as wide. Oral plates with a similar spine on the surface, at their distal end and a marginal series of 4 (in large specimens, 5) stout blunt spines, the innermost largest. Color in life "deep purple, or brownish-crimson or more nearly brown (but with surprisingly little difference) with deep orange tube-feet." Dry specimens unicolor, faded but with a distinctly purplish tint especially on the distal part of the rays. The largest specimen, which was uniform deep purple in life, now has the disk and basal part of rays dull orange and the distal margins and the distal part of the rays light violet.

Holotype, M. C. Z. no. 3305, dredged in 5–8 fms. in Koombana Bay, Bunbury, W. A., October 26, 1929.

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[1] *brevis* = short, in reference to the remarkably short actinal spines.

Our attention was first attracted to this sea-star by its handsome purple color quite different from anything we had noted in the hundreds of *gunnii* which we had seen at Point Peron and along shore at Bunbury. When we found that all of the Patiriellas dredged in Koombana Bay agreed in this striking coloration, our interest was quickened. Subsequently, Professor Bennett found the same form at Bunkers Bay and Ellen Brook Beach, which he kindly sent me with some additional specimens of large size from Bunbury. On November 2, 1929, while collecting along shore during low tide, at Port Willunga, South Australia, I found a very fine specimen of this sea-star about 80 mm. across. No specimens from further east have come under my notice.

The material in hand consists of 20 specimens ranging from 17 to nearly 90 mm. in diameter. There are 2 specimens with 7 rays among those dredged in Koombana Bay. There is room for considerable doubt whether this form is really a valid species or merely a variety of *gunnii*, a species which shows very great diversity in color and considerable in spinulation. But the more I have studied the material at hand, the more I feel convinced that *brevispina* is consistently and constantly distinct. Of course direct study of the question at Bunbury or some equally good locality may demonstrate that my conviction is ill-founded.

The 20 specimens of *brevispina* at hand are from the following places:

Western Australia: Bunbury, Koombana Bay, 5–8 fms., October 26, 1929. 14 specimens, small adults and young.
Bunbury; gift of Bunbury Naturalists Club through Professor E. W. Bennett, 3 large adults, in very poor condition.
Bunker's Bay, January, 1930. E. W. Bennett, leg. et don. 1 large adult; very poor.
Ellen Brook Beach, January, 1930. E. W. Bennett. 1 small adult.
South Australia: Port Willunga, November 2, 1929. 1 large adult; very fine.

PATIRIELLA NIGRA[1] sp. nov.

Plate 21, figs. 3–4

Very similar to *P. regularis* of New Zealand, so that structural differences on which any weight can be put are difficult to find. Only two or three are worth mentioning and it is quite possible that these are inconstant and worthless. There is little well-preserved material of *regularis* available (although a cotype of Verrill's and 66 other specimens are in the M. C. Z. collection); the best is an adult in alcohol and some small, dry adults collected in "New Zealand" and given to the Museum by Mr. Stanley L. Larnach in 1931. These specimens permit a careful comparison with the type of *nigra* which is in perfect condition, and the following differences are tangible; in the interradial areas the aboral plates in *regularis* carry relatively few spinelets (3–12) and this group rapidly becomes crescentic as one passes inward from the margin, and subtends a large papula; in *nigra*, these plates carry large dense groups of spinelets (12–15 or more) which cover the area closely and do not become crescentic until well up on the disk; again, the large inner marginal spines on the oral plates are distinctly flatter and more abruptly truncate in *nigra* than in any specimen of *regularis* I have seen; finally the 2 furrow spines in *nigra* are more nearly equal, more enlarged at base and more acute at tip then in *regularis*.

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[1] *niger* = black, in reference to the extraordinary color of the living animal.

These differences taken by themselves alone would not warrant the establishment of even a named variety but in connection with the locality where taken and the extraordinary color in life, it is justifiable to use a distinctive name. Color in life, black, "coal black" according to my field notes; it was certainly not a dark green or greenish-black nor a deep purplish-black, but simply a dead black; the lower surface was dusky. After killing in corrosive-formalin and drying, the lower surface became museum color around the margins but suffused with green inwardly from a definite boundary about 5 mm. from the margin; the aboral surface is dark green for 10–15 mm. inward from margin and then becomes rather abruptly brown-orange.

Holotype, M. C. Z. no. 3311, from under surface of a rock fragment near western margin of reef-flat at Neds Beach, Lord Howe Island, April 22, 1932.

On the evening of April 21, 1932, at a social gathering, a resident of Lord Howe, herself an enthusiastic collector of marine animals (particularly shells), asked me if we had found "the black starfish." Incredulously I replied that I had never seen or heard of such an animal but she assured me that she had found them at very low tides, although they seemed to be quite rare; they were to be found clinging to the underside of rock fragments and were "quite black all over." Mr. Livingstone and I discussed the matter later and agreed that she must have something else in mind than a sea-star. But the very next day, while making what was expected to be my last visit to Neds Beach, I turned over a rock fragment near the western edge of the reef-flat and there was a beautiful specimen of a perfectly black sea-star! The next day three of us worked for three hours on the same and adjoining parts of the reef-flat but in vain, no second specimen was secured. And the following day we bade adieu to Lord Howe.

At the Australian Museum, the following week, Livingstone showed me three specimens of Patiriella from Lord Howe Island, but they had all been preserved in alcohol and hence are simply museum color; there is no means of knowing what the color in life may have been. According to Farquhar (1895, p. 197), the New Zealand species *regularis* shows great diversity in color, "greenish-gray," "yellow, orange, purple, dull green variegated with yellow," "dark purple and many shades of blue." Of course if further collecting at Lord Howe reveals specimens of Patiriella which are not black, the status of *nigra* will be very dubious, yet the crowded spinulation of the interradial areas may warrant its retention as a variety. The holotype is an almost perfect pentagon with R = 27–28 mm. and r = 21; the vertical diameter is 10 mm. Thanks to Mr. Livingstone, one of the specimens from Lord Howe in the Australian Museum is at hand. It has R = 35 mm.; the spinulation of the interradii is dense and it may properly be considered an example of *nigra*.

NEPANTHIA BELCHERI

Asterina (Nepanthia) belcheri PERRIER, 1876. Arch. Zool. Exp., **5**, p. 240 (320 of reprint).
Henricia heteractis H. L. CLARK, 1909. Mem. Austral. Mus., **4**, p. 530.
Nepanthia polyplax DÖDERLEIN, 1926. K. Svenska Vet.-Akad. Handl. (3) **2**, no. 6, p. 20.

The determination of the systematic position of the Nepanthias which were taken at Lord Howe Island, and of specimens in the Australian Museum, loaned for identification, has caused me a great deal of perplexity. The best solution — the only one really satisfying — is to call them all a single species and apply to them the name *belcheri* Perrier, validated in 1884 by Bell. Having presumably examined the types in the British Museum, Bell assigned to *belcheri* a specimen from Port Jackson, thus fixing a definite locality for the species. As he does not suggest, in his exasperatingly brief reference, that his specimen had other than 7 arms (the number given by Perrier as characteristic of the species) but does state that it had 4 madreporites, Bell has added but very little to our knowledge of the species. Döderlein based his species *polyplax* on a single specimen of Nepanthia from "Rockhampton" (presumably Queensland) which had 6 rays and 6 madreporites. This striking symmetry seemed to him sufficient ground for the establishment of a new species. But material from Lord Howe Island shows that no reliance can be placed on the number of either arms or madreporites. Döderlein's admirable figures lead me to identify his species with the one occurring at Port Jackson and Lord Howe Island.

Placing this typical Nepanthia in the genus Henricia is the most absurd mistake of which I have been guilty in all my work on Echinoderms and is of course inexcusable. It can be accounted for only by my unfamiliarity with Nepanthia and overfamiliarity with Henricia in 1909.

This sea-star is one of the characteristic echinoderms of Lord Howe where it occurs on both sides of the island under rock fragments. Symmetrical specimens are rare; nearly all show evidence of autotomy to a greater or less degree. The color in life is an inconspicuous dark dull green indistinctly speckled orally with reddish. The color is fugacious and dry specimens are usually museum-color; occasionally however a specimen shows a marked purplish rose-color which persists for years.

It is a literal truth that no two of the 56 specimens at hand, nearly all from Lord Howe Island (4 being on loan from the Australian Museum), are exactly alike in number, size and form of arms, and in number of madreporites. Apparently 6 is the normal number of arms as 27 specimens show that number, while only 8 individuals have 7, 7 have 5, 3 have but 4, 1 has 8, 1 has but 3, and 1 is a single arm isolated but obviously in process of growth to become a "comet" such as are common in the autotomous reproduction of *Linckia guildingii*. Perfect "comets" in *belcheri* are by no means rare; one of the most typical consists of an arm 12 mm. long and 5.5 mm. wide, with 5 little arms about 4 mm. long radiating symmetrically from the oral end. Another very symmetrical specimen consists of an arm 18 mm. long, from the oral end of which radiate 4 arms 10 mm. in length. The 3-rayed specimen is obviously a hexamerous specimen so recently divided by autotomy that new rays have not yet become distinctly differentiated though growing tissue is evident. The 8-armed specimen has 2 arms 16–18 mm. long and 5, 11–12 mm., while the eighth arm, projecting only 4 mm. from the disk margin is obviously a supernumerary bud crowding in between two normal arms. As already stated symmetrical specimens are rare; there are 2 perfectly symmetrical pentamerous specimens, with R = 10 and 17 mm. respectively; the smaller has 2, the larger, 4 madreporites. A symmetrical hexamerous specimen with R = 30–32 mm. is the largest specimen of *belcheri* that we found at Lord Howe. It is not perfectly symmetrical however for, though there are 6 properly placed madreporites, one is twice as large as the others and is divided into two nearly distinct plates. A 7-armed specimen with R = 22–25 mm. is almost perfectly symmetrical as there are 7 madreporites of equal size located one in each interradius.

Aside from the number of rays and madreporites this species is easily distinguished from *brevis* by the fewer and coarser spines making up the oral and adambulacral armature; in *belcheri*, the larger ones are thickened at tip and blunt — which is not the case in *brevis*.

Specimens of *belcheri* from the mainland coast of Australia do not seem to be common. One was secured by the Great Barrier Reef Expedition and was assigned by Livingstone (1933, p. 262) with frank skepticism to "(?*brevis*)." He makes no reference to *polyplax* Döderlein and probably had not at the time of writing seen that author's figures. There are at hand 2 specimens loaned by the Australian Museum which were taken at the mouth of Lane Cove River, Port Jackson, many years ago and are listed by Whitelegge (1889, p. 201) as "*Patiria crassa* Gray." Years later, I (1925, p. 2) recorded a specimen in the Stockholm Museum from Lane Cove River and corrected Whitelegge's identification of the species, pointing out that the Lane Cove River specimens were identical with those from Lord Howe Island, which I carelessly persisted in calling "Henricia." The Stockholm specimen has 7 nearly equal arms, about 35 mm. long; it is probably one of Dr. Ramsay's original series.

Excepting the recently secured material from Lord Howe Island, all of the specimens at hand are old ones and the spinelets are more or less rubbed off, especially on the disk and basal part of rays, but aside from this artificial loss of spinelets the appearance of the two largest individuals indicates that after R = 30 mm. (or thereabouts) the spinelets are gradually replaced aborally by fewer, shorter and coarser, pointed outgrowths of the plates giving them a rougher coat and leaving the aboral surface of the animal relatively bare and not at all "velvety." Even on the oral surface a change to fewer and shorter spinelets is evident, but in the interradii and on the sides of the rays it is not very noticeable.

In order to summarize our present knowledge of Nepanthia, and set out the characters which apparently distinguish the various species, including the new ones described beyond, the following key is offered as a beginning towards a satisfactory understanding of the genus.

Key to the Species of Nepanthia

A. Arms long; R = 5-6r ±.
  A small supplemental plate proximal to each papula; furrow spines, 8-10; R a little more than 6r. . . . . *maculata*
  No conspicuous supplemental plates proximal to papulae; furrow spines, 5 or 6; R rather less than 6r. . . . . *tenuis*

A[1]. Arms short; R = 3–4r ±.

- B. Rays 5, swollen at base, then rather abruptly smaller; madreporite single...... *suffarcinata*
- B[1]. Not as above.
  - C. Rays 6 or 7 (rarely 5 or 8), short and thick in adults; madreporites 2–8; autotomy occurs very generally; adambulacral armature with about 5 furrow spines..*belcheri*[1]
  - C[1]. Rays typically 5 (occasionally 6, very rarely 7); madreporite usually single, 2 or 3 in multiradiate individuals; autotomous only when young; furrow-spines more than 5.
    - D. Aboral plates densely clothed with minute spinelets, almost like velvet; innermost oral spine not notable.
      - Aboral skeleton with numerous, short, wide crescentic plates, not arranged in very regular longitudinal series except near tip of arms. Adambulacral and oral armature of numerous very slender, acute spines........ ....*brevis*
      - Aboral skeleton with fewer, longer, narrower, more crescentic plates in very regular series; adambulacral and oral armature of fewer, coarse, blunt spines...*variabilis*
    - D[1]. Aboral plates with fewer, coarser spinelets, not at all velvety; innermost spine conspicuously large, flattened and acute............... *magnispina*

Of the above 7 supposedly valid and properly defined species, 5 are in the present collection — 2 previously known species from northeastern and eastern Australia and 3 hitherto undescribed species from the northwestern coast. On the western coast Nepanthia seems to be replaced by Parasterina. Sladen's species *suffarcinata* like *joubini* is non-Australian. No specimens of either species have come under my eyes.

NEPANTHIA BREVIS

Asterina (*Nepanthia*) *brevis* PERRIER, 1876. Arch. Zool. Exp., **5**, p. 241 (321 of reprint).
Nepanthia brevis SLADEN, 1889. "Challenger" Ast., p. 387.

This is the best known of the species of Nepanthia as it has been taken repeatedly in Torres Strait and on the coast of northern Queensland. As it has been figured by Bell (1884) and by myself (1921), there is little occasion for discussion of it here. Specimens in the Australian Museum, kindly sent to me for study, show considerable diversity in form and in spinulation but in view of the fact that these characters are profoundly affected by the condition of the specimen when killed (whether contracted or relaxed and to how great a degree) and by the method of killing and preservation, it would be absurd to try and distinguish species on such trivial details. It may be well however to record certain deviations from typical for the use of future students. A normal adult specimen of *brevis* has 5 arms and 1 madreporite; R = 40 mm. ± with r about one-third as much; the arms are blunt with the width near middle about one-fifth R and near tip, practically the same; at base the width is about equal to r. Some variations from this normal form are as follows: a specimen from Port Curtis, Queensland, has R = 30 mm. ± and r and br, at all points (except the very tip of arm) nearly or quite 9 mm. On the other hand a specimen in the Australian Museum (J 5151) has arms 45–50 mm. long with r = 15, and br = 14, 10 and 7 mm. at base, middle and near tip. Most specimens have 5 arms and a single madreporite, but two of the series at hand have 6 arms and a very small and irregular specimen has 7; of the two with 6 arms, one has 4 madreporites and the other 3, while the little 7-armed individual has 3 very small ones. One of the 6-armed specimens has tapering and somewhat pointed arms, but it is hard to tell how much this is due to the method of drying. The most constant character of *brevis* seems to be the long and very numerous slender spines making up the adambulacral and oral armatures.

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[1] Koehler's species *joubini* from Cochin China is so near to *belcheri*, no way of distinguishing them is available. Koehler himself makes no reference whatever to *belcheri*.

The discovery of *brevis* at Darwin was one of the interesting results of our collecting there as the range is thus extended far to the west. The 4 specimens dredged at the Shell Islands are very typical but the little 7-armed Nepanthia picked up on the beach at East Point is certainly an extreme variant, though there is no good reason, save the number of arms, for declining to call it *brevis*.

The 20 specimens of this species at hand range from R = 12 to R = 55 mm. They come from the following stations:

Queensland: Port Curtis, Rat Island. Ward and Boardman leg. 4 specimens, loaned by the Australian Museum.
Port Denison. 4 specimens, loaned by the Australian Museum.
At, and in vicinity of Thursday Island, 1928. Melbourne Ward leg. 5 specimens. Loaned by Australian Museum (nos. 5147–5151).

Northern Territory: Darwin, near Shell Islands, 2–3 fms., July, 1929. 4 specimens, 1 adult.
Darwin, near East Point, washed up on beach. 1 very young specimen with 7 rays.

Locality unknown. 2 specimens without labels or numbers. Loaned by Australian Museum.

NEPANTHIA MAGNISPINA[1] sp. nov.

Plate 20, figs. 1–2

Rays 5, but only 3 are normal, 2 at one side being very small, growth having only just begun; whether this is the result of autotomy or of an accident is not clear. R = 18, 28 and 32 mm.; r = 9; br = 9–11 mm.; arms high at base, about 7.5 mm. Aboral skeleton made up of more or less crescentic plates, about as wide as long, arranged in fairly definite longitudinal series; they are relatively narrower and longer than in *brevis*; the spiniferous ridge is narrow, more or less curved, and carries a dozen or more short, sharp, glassy spinelets; the surface is thus only sparsely covered and is not in the least "velvety." Inferomarginal plates relatively large and conspicuous forming a very definite margin to the rays. No madreporite is present but its absence is probably accidental.

Actinal intermediate plates in 5 or 6 series at base of ray but the two outermost series contain only 1 or 2 plates each; the next series contains 7 or 8 plates, the next has 35 plates and reaches nearly to the arm-tip; the innermost has as many plates as there are adambulacrals and accompanies that series to the tip of the arm. All actinal plates carry a tuft of short, sharp, divergent, glassy spinelets. Adambulacral plates with a furrow series of 4 or 5 divergent spines, which are neither slender nor stout, but the middle 3 are about as long as the plate margin and have opaque blunt tips; back of the furrow series is a second similar series of slightly smaller spines and on the surface of the plate are a few (1–6) much smaller spinelets. Oral plates each with 5 or 6 marginal spines similar to the largest furrow spines but the innermost is abruptly largest, 1.5–2 mm. in length, flattened but quite acute. Color, the usual yellowish-brown of museum material; color in life was not recorded.

Holotype, M. C. Z. no. 3320, from Augustus (or Champagay) Island, northern Western Australia, October, 1933. Captain Beresford E. Bardwell leg.

This was the only Nepanthia secured by Captain Bardwell and was supposed to be the species common at Broome but even a hasty examination showed it could not be placed there. It was then thought to be *brevis* but it is even more different from that species, particularly in the adambulacral and oral armature. It is therefore necessary to give it a distinctive name and await further material.

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[1] *magnus* = big + *spinus* = a spine, in reference to the innermost oral spine, which is unusually conspicuous.

NEPANTHIA TENUIS[1] sp. nov.

Plate 20, fig. 3

Rays 5, slender, terete and blunt, flattened orally. R = 64 mm., r and br = 11 mm.; hence R is a little less than 6 r or br. Aboral surface covered with very numerous small plates; on the disk and along the median area of each ray most of these plates are crescentic and subtend a papula but elsewhere they are rounded quadrangular; there is no small plate proximal to each papula; along the sides of the arms the plates form more or less regular longitudinal series. All plates are densely covered with minute, short, glassy spinelets, easily rubbed off in handling the dry specimen. Papulae large and numerous extending in several series to the tip of the arm. Madreporite single, large, about as far as its own diameter from the center of the disk.

Both supero- and inferomarginal plates are small and form no very well-defined boundary to the aboral surface. Actinal intermediate plates in about 7 series of which the 3 innermost extend nearly or quite to the tip of the arm; the series adjoining the ambulacral furrow is made up of much the largest plates; all actinal plates are densely covered with spinelets. Adambulacral armature of a furrow series of 5 or 6 relatively thick, blunt spines, a little longer perhaps than the adambulacral plate itself; back of that is a second and usually a third series of similar but slightly smaller spines, while on the outer end of the plate are some spinelets like those on the actinal plates. Each oral plate with a marginal series of 10–12 long spines, similar to the furrow spines but longer; on the surface of the plate is a large compact group of a dozen spines or more.

Color in life: "light gray with an indefinite whitish area on distal half of arm, with irregularly scattered small flecks of deep green; there is a reddish tinge to the gray and there are scattered white plates on basal half of arm. Lower surface white with a few scattered flecks of dull green along ambulacra." The dried specimen is uniformly museum-color.

Holotype, M. C. Z. no. 3321, from Roe Bank, 4 fms., outside Roebuck Bay, Broome, W. A., sand, shells and nullipore, June 20, 1932.

This fine Nepanthia, more like *maculata*, the genotype, than any of the other species is readily distinguished by the character of the dorsal skeleton and the adambulacral armature. Fortunately Sladen (1889) was wise enough to give figures of these features as they are in *maculata*, so that in spite of the rarity of that species it is possible to understand easily how different from it the Western Australian species is. That *tenuis* is not common at Broome is evident from the facts that we did not meet with it at all in 1929, there are no specimens in the Museums at either Perth or Sydney and in 1932 we only secured 2 specimens besides the holotype. These are both much smaller; one has R = 45 mm. while in the other it is about 38.

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[1] *tenuis* = slender, in reference to the arms which are so much more slender than in the common Nepanthia of the same region.

Nepanthia variabilis[1] sp. nov.

Plate **10**, figs. 4–5. Plate **20**, figs. 4–5

Rays 5, rarely 6 in adults, rather stout, more or less tapering. R = 60 mm., r and br = 13; hence R = about 4.5r or br. While these measurements of the holotype are typical there is considerable diversity on both sides of this normal form. Aboral skeleton as in *brevis*, and other typical members of the genus — crescentic plates on median area of arms, with rounded quadrilateral plates in longitudinal series on the sides. Spiniferous ridges on the plates well developed and well covered with little spinelets but owing to the breadth and depth of the areas between the ridges the aboral surface is not smooth or velvety. Papulae large and numerous, all over sides and top of arms. Madreporic plate single, rather large, nearer to center of disk than to margin; when there are 6 arms, there are 2 or 3 madreporites, but in small individuals (R less than 15 mm.) it is usually hard to find any madreporite at all.

Marginal plates small but inferomarginals are easily distinguishable and form a definite boundary to the oral surface. Actinal intermediate plates in about 7 series at very base of ray but only 4 series extend to middle of ray and of these only the innermost goes clear to the tip of the arm. Each actinal plate is closely covered with a dense coat of small spinelets. Adambulacral armature, much as in *tenuis* — a furrow series of 5 or 6 relatively stout, blunt spines, a similar slightly smaller series back of it, in which the individual spines are commonly stouter (at least near base of arm) than those of the furrow series; the remainder of the plate is covered by a third series of spines, or by little spinelets or by both. Each oral plate has about 8 marginal spines, much like those in the furrow series of the proximal adambulacrals but longer; on the surface of the plate is an elongated cluster of more or less similar spines.

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[1] *variabilis* = marked by diversity, in reference to the remarkable diversity in form and color which this sea-star exhibits.

Color in life, very diversified and often brilliant; the dry specimens are usually museum-color but many show blotches of dusky and these are quite conspicuous in some of the smaller specimens.

Holotype, M. C. Z. no. 3323, from Broome, W. A., August, 1929.

The diversity of this sea-star is really extraordinary. As regards form, differences in the slenderness of the rays, in the degree to which they taper, in the bluntness or acuteness of the tip, in their relative height at base and even in their number lead to remarkably unlike-looking specimens. In color, the diversity is even more notable, so great as to be almost unbelievable. A few extracts from my field notes will make this evident: "Variegated, white, light orange-brown and liver-brown;" "variegated greens and whitish, rather like *brevis*;" "bright red, adambulacral spines black, just the very tips almost white, tube-feet white with tips almost black;" "light fawn color with a very few (about 5) irregular small blotches of bright dark brown, oral and adambulacral spines deep green;" "disk and base of rays aborally bright light violet, madreporite pale green, remainder of rays variegated whitish and light brown with a few widely scattered irregular small blotches of crimson; oral surface near margin pale fawn color but near mouth and grooves the tufts of spinelets are rusty; oral and adambulacral spines deep green;" "variegated whitish and light brown (some blotches are black brown) with irregular blotches of bright rose-color, lower surface fawn and rust-color, oral and adambulacral spines green;" "variegated white and red-violet, oral surface pale pink-brown (almost salmon) with oral and adambulacral spines and adjoining spinelets deep blue-green in sharp contrast;" "white mottled with black especially on disk and base of arms with a very few inconspicuous blotches of purple-brown, madreporite cream-color;" "bright orange-red with center of disk vermilion, distal portion of arms variegated with cream-color and vermilion, oral surface, orange, oral and adambulacral spines more or less brown distally;" "almost rose-red."

Most of the above specimens were collected along shore in Roebuck Bay, August 26, 1929, but a few were dredged. In their present dry condition there is still considerable diversity but the majority are museum color of a darker or lighter shade; some show distinct blotches of dusky or dull reddish, some have a reddish or purplish tinge and one small specimen is a rather bright rose-red aborally.

Growth changes are interesting. All specimens with R = 13 mm. or less are either symmetrically hexamerous (3 specimens) or have obviously undergone autotomous division (4 specimens); of the latter, 3 have 2 large and 4 small arms and one has 2 large and 3 smaller arms. Another specimen is almost a "comet" having one arm with R = 16 mm. and 5 additional arms with R = 7–12 mm. All other specimens with R = 15 mm. or more are symmetrical pentamerous specimens except a few that are obviously regenerating one or more rays lost by accident of some kind, and three individuals which each deserve a word of comment; one is a perfectly tetramerous individual (with R = 30 mm.); one is a hexamerous adult with R = 42–52 mm.; and one is a hexamerous specimen in which R = 30 mm. in two adjoining arms and 23–25 mm. in the other 4, undoubtedly a case in which a hexamerous adult is developing after autotomy and interesting as showing that hexamerous specimens do not necessarily arise, as might be supposed, from the 3-armed half (after autotomy of a 5-armed specimen) giving rise to 3 additional arms instead of 2. Mortensen (1933, p. 276) has given it as his opinion that "the idea that species normally 6-armed and self-dividing as young transform into 5-armed, non-dividing adult, is a mistake — for Asteroids as well as Ophiuroids." In my opinion, my good friend is mistaken — the present species of Nepanthia seems to me to be unquestionably one in which young hexamerous individuals give rise through autotomy to symmetrical, non-dividing pentamerous adults. Occasionally hexamerous adults arise but they are the rare exception.

Another growth change that deserves some comment is in the abundance and distribution of the spinelets on the aboral plates. Orally the changes are less noticeable. In all young specimens, until the arms are 20–25 mm. long the larger aboral plates are well-covered, though not densely so, with the usual minute spinelets and the smaller plates have a more or less evident tuft of the same. As growth proceeds however and size increases, we find two divergent tendencies. In some individuals, usually (but not always) those with wide, blunt arms, the spinelets seem to increase but little in number and hence occupy only the raised portion of the expanding plates, and at the same time, they increase in size particularly in thickness at base; the surface of the adult thus becomes rougher, with the individual plates increasingly conspicuous. On the other hand in some individuals, usually with slender tapering arms, the spinelets increase greatly in number and cover the plates large and small so completely that the surface assumes a "velvety" appearance and feeling. The difference between the two extremes is striking but as it is not associated with other distinguishing characters and as there are many intermediate specimens, it can be regarded only as "individual diversity." It suggests however that two allied but quite distinct species might arise very easily and naturally by some change in environment that led to a keener struggle for survival.

This is one of the common and characteristic sea-stars of the Broome area. We did not find it at Cape Leveque but it occurs at False Cape Bossut and in Lagrange Bay. There are 51 specimens at hand, the largest having R = 64–67 mm.

PARASTERINA CRASSA

Patiria ? crassa GRAY, 1847. Proc. Zool. Soc. London, p. 83.
Parasterina crassa FISHER, 1908. Smithson. Misc. Coll., **52**, p. 90.

On October 7, 1929, we spent a most interesting day at Geraldton, W. A., and among the echinoderms collected along shore were two small Nepanthia-like sea-stars, which prove to be young examples of Gray's species. They show a distinct difference in form, for one has R = 28 mm., br = 7, R = 4br, while the other has R = 25 mm., br = 8, R = 3br. Otherwise they agree well, particularly in the considerable number of enlarged swollen, aboral plates characteristic of the species.

We did not meet with another specimen of *crassa* during our further collecting on the Western Australian coast but Mr. Glauert kindly loaned me 6 specimens from the Perth Museum and Professor Bennett has sent 6 specimens. Of the Perth Museum specimens, a 6-armed one from Garden Island is most notable; it is a large individual (R = 50 mm. ±) in poor condition; one ray is distinctly smaller than the others. Of the other specimens 4 were found at Cottesloe Beach and the fifth was found on the piles of an old jetty at Fremantle.

Of the specimens sent by Professor Bennett, 3 are from Dongarra and 2 deserve special comment; one is perfectly tetramerous and has R about 23 mm.; the other has the five arms, 33–35 mm. long and 11 mm. thick, very blunt, the aboral surface almost completely covered by the enlarged swollen plates; no other specimen is comparable in this particular. Of the other 3 specimens, 1 is from jetty piles at Rockingham, the other 2 have no locality label. One of these however is notable for its unusually heavy, stout structure and large size; R = 64 mm., r and br, 17 or 18 mm., R = 3.7r or br. The vertical diameter of the disk and base of rays is 14 mm. The enlarged, swollen aboral plates are numerous but not excessively so. Unfortunately none of the specimens at hand have any notes as to the color in life. The smaller specimen of the two from an unknown locality sent by Professor Bennett has a very definite dull brownish-red color and my recollection of the specimens found at Geraldton is that they were red-brown.

PARASTERINA TROUGHTONI

LIVINGSTONE, 1934. Rec. Austral. Mus., **19**, p. 179.

Among the sea-stars loaned me by the Perth Museum are two specimens of this recently described species. One is a trifle larger than Livingstone's unique holotype (R = 16–18 mm.) but the other is twice as big (R = 32–34 mm.). The species characters are well marked, particularly in the larger specimen. The holotype was taken at Albany, W. A., but there is no locality known for the two specimens in hand, though they are supposed to be from Western Australia. Both specimens are typical museum color.

PARASTERINA OCCIDENTALIS[1] sp. nov.

Plate **21**, fig. 5

Rays 5, long and slender. R = 29 mm., r and br = 7.5 mm. R = almost 4r or br. Rays wide, with oral surface flat, sides nearly or quite parallel and tips very bluntly rounded. Aboral surface closely covered with thick plates, each plate densely covered with a coat of minute, short, truncate spinelets; papulae rather large so placed that there is one at each corner of every plate, but sunken almost out of sight so closely placed are the plates; aboral surface looks and feels very smooth, so crowded are both plates and spinelets; plates are of two sorts, rhombic more or less equilateral, or longer than wide (in the interradial areas and along sides of ray nearly to tip) and irregularly diamond-shape wider than long (distal portion of arm and thence forming a median band narrowest at disk). Disk itself covered by irregularly polygonal plates not noticeably different from those at base of arms. Terminal plate rather large and projecting but covered by short, minute spinelets. Madreporite small, triangular, sunken, half-way between disk center and margin.

Marginal plates noticeable, if not conspicuous, in a uniform double series at the margin of the disk and arms. Superomarginal plates unusually large and noticeable, corresponding in size, form and position with the inferomarginals. Only one series of actinal intermediate plates extends to the tip of the ray, the plates corresponding in number and position with the adambulacrals and also with the inferomarginals; on basal third of ray, a second series of much smaller plates, 16 or 17 in number, extends as far as the twelfth inferomarginal; a third series of 7 or 8 similar plates extends to the fifth inferomarginal, and half a dozen more fill up the rest of the intermediate area. Adambulacral armature made up of a furrow series of 4 or 5 subequal, rather stout spines with bluntly rounded tips, and a subambulacral group of 10–12 similarly thick and blunt but much shorter spines on the surface of the plate; the inner 4 or 5 of this group are sometimes arranged so that they seem to form a second series back of the furrow series but this is rarely evident. Each oral plate with a marginal series of half a dozen spines subequal or the innermost longest, similar to but larger than the adambulacral furrow-series; in large specimens the inner spines become almost prismatic at tip; on the surface of each plate is a longitudinal double series of smaller spines, about 5 in the outer row and 2 in the inner. Taken altogether both adambulacral and oral plates are pretty well covered with spines. Color in life, dull rose-red (in other specimens, a more crimson-red is marked), completely lost after drying.

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[1] *occidentalis* = of the west, in reference to its being characteristic of the western coast of Australia.

Holotype, M. C. Z. No. 3332, from a small cavern under a big rock at Point Peron, W. A., October, 1929.

Although we did not meet with this species again, Mr. Glauert has loaned me 5 specimens and Professor Bennett has given me two, which however have no data with them and are in rather poor condition. Of the Perth Museum specimens, 2 in very poor condition are from Shag Rocks, Penguin Island, while the others are from near Fremantle. From Cottesloe Beach is a good gray-brown specimen, with R nearly 40 mm., the arms tapering to a blunt point. A fine specimen from Garden Island, with R = 55–56 mm. and br = 11 (hence R = 5br) is painted brick-red, presumably as in life. The largest specimen of all is from North Beach, Fremantle, and has R = 65 mm., and br = 14; the color is yellowish-brown. This species is very well defined and cannot be confused with any other now known.

ANSEROPODA ROSACEA

Asterias rosaceus LAMARCK, 1816. Anim. s. Vert., **2**, p. 558.

Anseropoda rosacea FISHER, 1906. Bull. U. S. Fish Comm., p. 1089.

While at Broome in 1929, a local shell collector showed me a fragment of a specimen of this sea-star and said it came from Eighty Mile Beach. Although we sought eagerly to find a specimen, we were not so fortunate. In 1932 however, on the afternoon of June 20th, while dredging in 4 fms. on Roe Bank just outside Roebuck Bay, we took 25 specimens. Oddly enough we did not again meet with the species. My field notes say: "All of the specimens are more or less damaged though some of the largest are nearly perfect. The color underwent no change in preservation; the upper side is variegated gray like the coarse sand on which the animal lives; the lower side is creamy white with more or less rust color along the ambulacral grooves." On drying, the gray tints tend to become brown but otherwise there is very little change. Obviously the specific name selected by Lamarck has no reference whatever to color but only to a fancied resemblance in form, to a rose.

Of the 25 specimens, one is too badly damaged to permit counting the rays but of the other 24 plus a small specimen loaned by the Australian Museum

1 has 11 rays
1 has 13
1 (the smallest) has 14
1 has 14½, as one furrow forks!
7 have 15
10 have 16
4 have 17

Evidently less than 16 is the typical number of rays (at Broome) but with nearly three times as many having fewer than having more. The average for the 25 specimens is only 15.4 rays. The smallest specimen has R = 30–35 mm. while the largest has R = 115–120 mm. As a rule, R = 1.12–1.16r. The chief diversity shown is in the form of the tips of the rays, which range from rather acutely pointed to broadly rounded. The terminal plate is usually quite conspicuous and often the tip of the ray is tipped up in such a way as to make the plate more than normally noticeable.

The specimen loaned by the Australian Museum is the most perfect one I have seen. It is only 75–80 mm. in diameter and the margin curves downward, so that the form is surprisingly like a certain type of Japanese umbrella. There are 15 rays and the terminal plate is a conspicuous tip to each one. Mr. R. A. Bourne, master of the "Bonza," took this specimen in 1930, between Broome and Wallal.

ECHINASTERIDAE

Echinaster arcystatus

H. L. Clark, 1914. Rec. W. Austral. Mus., **1**, p. 148.

We did not meet with this species but Professor Bennett has kindly given me a fine specimen from "a weedy reef" at Bunkers Bay, southwestern Western Australia taken by him in January, 1930. The arms are more than usually short and stout; R = 87 mm. but br = 19, so that R is only about 4.5br. The color is brown, the lower surfaces and the coarse aboral network lighter than the ground color of the upper surface.

Echinaster superbus

H. L. Clark, 1916. "Endeavour" Rep, p. 64.

While working in Pender Bay, June 16, 1932, our diver, Wan, brought up what still seems to me one of the most remarkable sea-stars I have ever seen as it was certainly one of the handsomest. More careful examination showed it to be a very large specimen of this species, of which the colors in life had not previously been known. The description in my field note-book is as follows: "The upper surface is a fairly light yellowish-green, with center of disk and five large blotches, arranged longitudinally on each ray and diminishing in size distally, a distinctly darker shade; on these darker areas the extraordinary spines are rose-color, elsewhere they are cream-white; lower surface, cream-white; feet white; oral armature lavender, this color extending distally a little way on the adambulacral spines; papulae pale brown; more or less greenish dorsally." Wan reported that he found this beautiful sea-star "on top of a rock." We did not meet with another specimen but two from the Perth Museum, kindly loaned by Mr. Glauert, are at hand. One of these (2985) from an unknown locality with R = 143 mm. is only a trifle smaller than the Pender Bay specimen in which R = 145 mm., r = 24 and br = 27.5. The color is a fairly uniform light reddish-brown with a lavender cast. In the Pender Bay specimen the spines are shorter, stouter, more numerous and more extraordinarily clavate than in no. 2985; in the latter, a rather conspicuous bare area runs longitudinally along each side of the series of big actinal spines which parallels the adambulacral furrow. These bare strips were rather evident in the unique holotype (see H. L. Clark, 1916, pl. XXV) but are not evident in the Pender Bay specimen nor in the second specimen from the Perth Museum.

The latter, though much smaller (R = 110 mm., as in the holotype), resembles the big Pender Bay specimen in its spines, more nearly than it does no. 2985. It was taken at Broome in 1914 and has been varnished, probably in a futile effort to preserve the remarkable coloration; the present color is a dark reddish-brown, the tips of the spines brownish-yellow. The Pender Bay specimen has lost all traces of green or white but many aboral spines still retain an evident rose-red color.

ECHINASTER VARICOLOR[1] sp. nov.

Plate 11, fig. 1

Rays 5, stout, terete, bluntly pointed. R = 160 mm., more or less; r = 16, br = 22–24; R = 10r, but only about 7br. Aboral skeleton irregularly reticulate but even in dried specimens not conspicuous, bearing many low spines, 1–1.5 mm. high, .5–1 mm. thick at base; there are 10–15 of these spines to each square centimeter, but they are least numerous proximally and most numerous near the arm tips; they are bluntly rounded or truncate and often concave or pitted at tip. No marginal plates are distinguishable. Madreporite very small, only 2 mm. across, about 8 mm. from center of disk.

Oral surface similar to aboral but the spines are somewhat longer. Papulae are numerous to within 5 mm. of the ambulacral furrow. Adambulacral armature at middle of arm consists of a single large marginal spine about 3 mm. long, sometimes tapering to a blunt point but more often strongly flattened into a chisel-like tip more than a millimeter wide, usually at right angles to the furrow; within the furrow attached to the base of the big spine is a rather short and blunt spine even its tip lower than the surface of the actinal plates; on many plates a small subambulacral spine, similar to those on the actinal plates, is present back of the big spine; at the base of the arm this spine is present on every adambulacral plate but at the middle and distally its occurrence is irregular. The lowest row of actinal plates (nearest the furrow) carries spines rather evidently larger than the others and at some places on some of the arms this series of actinal spines is noticeable, but it is irregular in its development and is never conspicuous. Oral plates with 3 or 4 big, clavate spines on the free margin, below which deep in the mouth are two small spines; on the surface of each plate there may be a small spine but this is frequently lacking. Color in life deep buff, spotted with red-purple; dried specimen uniform bright red-brown becoming yellow-brown along the ambulacral furrows.

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[1] *varicolor* = of diverse colors, in reference to the different color forms noted in living specimens.

Holotype, M. C. Z. no. 3339 from sandy bottom, southwest of Broome, 5–8 fms., June, 1932.

The diversity of color shown in life by this fine Echinaster is so remarkable that I supposed I had 3 species until careful study showed that aside from color there are no characters whatever by which specimens can be distinguished. The first specimens taken were from far south of Broome and were buff, spotted with red-purple; while there was individual difference in the number and size of the spots, there was no question as to the identity of the specimens. The following week, while working to the north of Broome, Wan, the diver, brought up a fine, large Echinaster, uniformly violet in color, though somewhat yellowish along the ambulacral grooves. Subsequently specimens intermediate between the spotted and unicolor forms were taken and it became probable that only one species was involved. Finally, in Roebuck Bay, we took an Echinaster of rather smaller size, uniformly bright red in color without trace of buff or violet; several specimens were ultimately secured. On being dried, the three color forms became unicolor, the shade ranging from yellow-brown, through brown, to deep red-brown; some specimens are a very bright red brown, but there is no correlation between the color in life and the present shades. In all specimens the adambulacral armature and more or less of the adjoining actinal surface is yellowish or brownish-yellow.

All of the specimens have 5 arms but several have met with mishaps and are regenerating lost rays; the worst case has one arm normal, about 115 mm. long, a second arm about 100 mm. long gives some indication of having regenerated from close to the disk, a third arm has 30 mm. of the old arm base and 35 mm. regenerated distally, a fourth has 20 mm. of the old arm and 30 of the new, while the fifth arm lost close to the disk has just begun its regeneration. Whether marauding fishes are the cause of such mishaps one can only guess.

No very small Echinasters were taken — the smallest has R = 86 mm. while in the largest R = 190 mm. The proportion of major and minor radius ranges from R = 8 to 10r, and the slenderness of the arms ranges from R = 6 to 8.5 br. It is worth noting that br seems to always exceed r, often very considerably.

This sea-star is fairly common in the Broome region but we did not meet with it in 1929, probably because it does not occur along shore and we did comparatively little dredging. In our extensive dredging and use of a diver in 1932, we secured 26 specimens. For the convenience of future field workers the 3 color forms may be designated as forma *maculata*, forma *violacea* and forma *rubra*.

The relationship of *varicolor* to *luzonicus* is perfectly obvious but the differences in life are even more so. Aside from size and color however, it is difficult to specify any point in which there is a clear cut distinction. When dry specimens of the same size are compared, it is evident that the spinelets are larger and less numerous, the skeletal network more open, in *varicolor*. Near the tip of the ray in *luzonicus*, the subambulacral spinelets form a very definite series close to, and parallel with, the adambulacrals, and often a series of actinal spinelets runs along just outside the subambulacrals. In *varicolor* there are no continuous series of spinelets outside the adambulacrals, the subambulacrals and actinal spinelets being scattered and irregular in their linear arrangement. The adambulacral spines in *varicolor* are more flattened and much wider at the tip than in *luzonicus* but this is a difference of degree only. To sum up, it may be said that *luzonicus* is a small species with R = 75–100 mm., usually with 5, but often with 6 or even 7 arms, reproducing autotomously; the rays are relatively slender, covered with numerous small spinelets; distally the subambulacral and adjoining actinal spines tend to form longitudinal series parallel to the adambulacrals; adambulacral spines often somewhat flattened at tip; color rusty-red speckled with blackish, or often the blackish color spreads over the whole dorsal surface; there is no violet or purple in the coloration. On the other hand *varicolor* is a very large, strictly 5-rayed species, not autotomous, with R = 150–190 mm.; the rays are stout but terete, covered with coarse spinelets, relatively less numerous than in *luzonicus;* on the distal portion of the arms, the spinelets do not form definite longitudinal series parallel to the adambulacral spines; the latter are markedly compressed and widened at tip particularly on the basal part of the arm; color deep buff spotted with purple, or uniformly violet or bright red, with no black or dusky spots or shade. The uniformly violet specimens suggest the possibility of identity with *Echinaster purpureus* of East Africa and Mauritius but the shape of the arms and the absence of a wide bare strip parallel to the ambulacral furrow are adequate differences.

PLECTASTER DECANUS

Echinaster decanus MÜLLER and TROSCHEL, 1843. Arch. f. Naturg., **9** (1), p. 114.
Plectaster decanus SLADEN, 1889. "Challenger" Ast., p. 535.

Of course I regretted not having the opportunity to see this odd sea-star alive but fortune did not favor me. Professor Bennett has however sent me a good specimen with R = 90 mm. ± taken by Mr. D. L. Serventy, February 23, 1930, while on the trawler "Bonthorpe" in the western end of the Great Australian Bight, 33° 15′ S x 126° 22′ 15″ E, 90 fms. Mr. Serventy has attached a color note to the specimen reading "Red and purple patches," which I construe as meaning that in life the skeletal parts are red and the large papular areas purple.

METRODIRIDAE

METRODIRA SUBULATA

Plate 11, fig. 3

GRAY, 1840. Ann. Mag. Nat. Hist., 6, p. 282.

Near the entrance to Roebuck Bay, in 4–7 fms., this peculiar sea-star was not rare and we secured 16 specimens, ranging from R = 16 to R = 72 mm. As the largest previously known specimen seems to be the one described and figured by Koehler (1910, p. 284) which had R = 60–65 mm., these larger specimens are of particular interest. The 16 specimens show no little diversity in the slenderness of the arms, in the degree to which their aboral surface is flattened and in the size and number of the aboral spinelets. At one extreme is a specimen with slender, terete arms, in which R = 55 mm., r = 8 mm., and br = 7 mm., and at the other is an individual with broad, flattened arms, in which R = 60 mm., r = 10 mm. and br = 10 mm. Hence the relative proportions range from R = 6–7r and 6–8 br. In the slender-armed specimens, the aboral spinelets are small, usually single, about 10–12 in a space 3 mm. square while in the broad-armed specimens the spinelets are larger, often in transverse series of 3 or 4, and 15–20 in a 3 mm. square. The two forms intergrade completely. A specimen with R = 68 mm. is perfectly tetramerous.

The most interesting thing about the finding of Metrodira was the discovery of its unexpectedly handsome colors in life. Museum specimens are so universally yellow-brown, pale-brown, dirty yellowish or nearly white that it has never been suspected that the colors are very unlike any known Echinasters. My field notes describe the living animal thus: "A most attractive sea-star; pure white beneath; light gray with dull blue-gray blotches; each papula surrounded by a rust-colored ring." The gray has a distinctly bluish tint so that the effect is of a blue and white sea-star with small orange-brown circles on the upper side.

Besides the 16 specimens taken at Broome, there are 3 other specimens at hand. One is a loan from the Perth Museum and was taken at Canarvon in 1927 by Dr. Ehrenreich. Aside from the remarkable extension of the species range to the southwest, this specimen is of more than usual interest because of its short wide arms: R = 54–56 mm. while r and br = 10; hence R = 5.5 r or br. However the specimen was evidently dried slowly and the width of the arms is thus unnaturally increased a little.

The other 2 specimens show an equally notable extension of the range of Metrodira to the southeast, for Mr. Ward took them at Lindeman Island in "July-Sept., 1934." They are further notable for large size and very slender arms; R = 82 mm. in the larger specimen and br is only about 9 mm.; hence R = 9br. These specimens, now dry, are a dingy, but rather dark brown, very different from the other specimens, but no morphological differences have been found.

PTERASTERIDAE

Retaster insignis

Sladen, 1882. Jour. Linn. Soc. London, **16**, p. 200.

The appearance of this sea-star in life is so unusual, so different from museum specimens, that the taking of several just outside Roebuck Bay on June 13, 1932, in 5–8 fms. was a most interesting surprise. The brilliant color and the extraordinarily slimy surface were quite unexpected, aside from the fact that the species was previously known only from the East Indian region, Torres Strait and eastern coast of Australia. Additional specimens subsequently taken in the same vicinity showed the same remarkable characters. Altogether 13 specimens were secured ranging from R = 42 to R = 80 mm. The ratio of R to r shows little diversity; it is least in the smallest specimen where R = 2.2r or 2br while in a specimen with R = 68 mm. the other extreme is reached, as R = 2.7r or 2.4br. One specimen with R = 80 mm. and one with R = 60 mm. have 6 rays each but are not perfectly symmetrical, one arm (or two) being somewhat smaller than the others. The color in life is given as follows in my field notes: "One was bright vermilion red, one deep vermilion while others had net work red but areas greenish yellow." Most of the specimens were more or less completely bright red. In addition to this very striking color, the appearance was made even more remarkable by the fact that every specimen was covered with a layer of perfectly transparent colorless jelly making the specimens slimy and unpleasant to handle. On one specimen this layer was 6 mm. or more in thickness, so that none of the spines which cover the animal projected beyond it. The jelly had little consistency however and disappeared quickly as the specimens were handled and being preserved. It left no trace behind in the dry specimens. But it may have a protective function in life.

The Perth Museum has loaned me a specimen of this species from Shark Bay, notable not only for the locality so far to the southwest of Broome but also for its large size; with R = 83 and br = 41.5 mm., it is distinctly the largest specimen yet recorded. Mr. Ward has sent from Lindeman Island, Queensland, the smallest specimen which has yet been taken. It is a perfectly symmetrical pentamerous individual with R = 14 mm. and r and br scarcely 6; it is interesting to find the ratio identical with that of adults. The species characters are well shown even in so young a specimen.

ASTERIIDAE

COSCINASTERIAS CALAMARIA

Asterias calamaria GRAY, 1840. Ann. Mag. Nat. Hist., 6, p. 179.
Coscinasterias calamaria PERRIER, 1894. "Travailleur et Talisman" Stell., p. 106.

This sea-star is widespread in the non-tropical waters of Australia, as it is common at Lord Howe Island on the east and at Rottnest on the west, and apparently at all suitable places between along the southern coasts of the continent. The number of rays ranges from 7 to 11, but large symmetrical specimens, with R exceeding 100 mm., commonly have 11. However autotomy and regeneration are so continually taking place that even very large specimens often have one or more small rays. The specimens at hand from Hobart, Tasmania, are particularly large and fine. They are like the one called *gemmifera* (Perrier) in the "Endeavour" Report (H. L. Clark, 1916, p. 74) but after careful comparison of many specimens of all sizes from various places, I am convinced that the Tasmanian specimens are not essentially different from other Australian material and all should be called *calamaria*. Incidentally I may add that I have compared specimens of similar size from Mauritius, Western Australia, South Australia, New South Wales, Lord Howe Island and New Zealand, and find no characters by which to satisfactorily distinguish them. The number of pedicellariae and the distribution of the large ones is very diverse and this gives a different facies in extreme cases. Thus a Mauritius specimen has few pedicellariae, no large ones, while a New Zealand specimen has a great many large ones and few small ones so that at first sight they seem quite unlike. New Zealand specimens show much diversity among themselves in spinulation as well as in pedicellariae.

The color in life of *calamaria* shows some diversity. Quoting my field notes we find that at Hobart: "Largest was brownish-yellow, the huge circles of pedicellariae on the dorsal spines (which swell up around and even above the spine tip, so that it looks like a small zoanthus) dull bluish. Other specimens were olive-greenish with spines blue and lower surface cream-color." At Lord Howe: "Color very varied usually blue or bluish variegated with brown of several shades (rarely reddish) and olive-greenish. Some specimens show almost no blue. Colors fugitive and blue especially fugacious." At Port Willunga, S. A.: "Brown and dull bluish with many large spines bright, deep blue." At Rottnest and Point Peron: "Colors very variable and fugacious; a common color is dull blue with disk and more or less of the ray-bases, bright brown, but greenish shades instead of blue, are frequent; variegation with bluish, brown and grayish shades is the rule."

The 63 specimens at hand are from the following widely separated localities:

- Lord Howe Island: April, 1932. 5 specimens, 4 very small.
- New South Wales: Port Jackson, Bottle and Glass Rocks, November 27, 1929. 6 specimens, young and unsymmetrical.
    - Gunnamatta Bay, November 26, 1929. 4 specimens, 1 large adult and 3 half grown.
    - Shell Harbor, May 4, 1932. 6 specimens, young and unsymmetrical.
- Tasmania: Hobart, estuary of the Derwent, November 15, 1929. 3 specimens, 2 very large and symmetrical.
- South Australia: Port Willunga, November 2, 1929. 1 specimen, small but symmetrically 10-armed.
- Western Australia: Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 4 specimens, adult and young.
    - Point Peron, October, 1929. 5 specimens, young.
    - Rottnest Island, October, 1929. 19 specimens, young and very young; one only 8 mm. across, with 7 arms.
    - Rottnest Island, 1934. Captain B. E. Bardwell leg. et don. 7 specimens, small adults and young.
    - Garden Island, July, 1932. 2 specimens, very young.
    - Cottesloe Beach, July, 1932. 1 specimen, young; 4 rays, and 5 buds of rays just starting on opposite side of disk.

ASTROSTOLE INSULARIS[1] sp. nov.

Plate 8, fig. 1

Rays 7, moderately wide, bluntly pointed and flattened in dry specimen, more nearly cylindrical in life. R = 77 mm.; r = 10; br = 8 at base but 10–12 mm. near middle of arm. R = nearly 8r and 9.5 br. Disk of moderate size with a firm skeleton and small interspaces. Aboral skeleton of arm consists of 5 series of stout plates, a carinal and a dorsolateral on each side, below which are the stout superomarginals, the largest of the skeletal plates. Carinal plates roughly pentagonal or diamond-shape with rounded or truncate angles, closely united with each other in the midline; every other one (distally every third or fourth) carries a stout bluntly pointed spine, 2–3 mm. long, with a heavy wreath of pedicellariae about its base; dorsolateral series of small irregular plates, a very variable number of which carry a single small wreathed spine. Superomarginal plates irregularly rounded triangular, wider than long, broadly in contact with each other at the upper end, in contact with the inferomarginals by a narrow outer end and still more narrowly in contact at the upper, distal corner with the small dorsolaterals; every second or third plate carries a large wreathed spine like that on the carinals; a considerable area of each plate has a distinct shagreen surface. Madreporite single, 3 mm. across, 5 mm. from center of disk.

Inferomarginals large, longer than wide, forming (with the spines they bear) a conspicuous margin to the arm; each plate has an oblique ridge, the lower end of which is more distal than the upper; on this ridge is a pair of somewhat flattened spines, the upper one 4–5 mm. long, a millimeter or more in width, with a bluntly pointed or rounded tip; the lower spine is about 3.5 mm. long, less than a millimeter wide and has a square cut tip. Actinal plates small but distinct on basal two-thirds of arm, widely spaced so that each plate is in close contact with lower end of ridge on inferomarginal plate; it carries a flattened square-cut spine somewhat smaller than the lower inferomarginal as though it were a third member of that series; the uppermost of the 3 spines (i.e. the upper inferomarginal) carries a cluster of forcipiform pedicellariae, on its upper surface near the middle or at its base.

Adambulacral plates short and crowded; each carries a pair of narrow chisel-shaped spines, about 2.5 mm. long, the inner a trifle shorter and distinctly narrower than the outer; the tips of the latter are a trifle widened. Oral plates small, each with 2 spines, a large one at the inner end and a smaller more pointed one on the outer corner. There are 4 contiguous pairs of post-oral adambulacral plates, each carrying one large spine on its margin.

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[1] *insularis* = pertaining to an island, in reference to the type locality at Lord Howe.

Pedicellariae relatively few; the forcipiform are confined to the clusters on the aboral and marginal spines; few if any are scattered on the surface; forficiform pedicellariae of diverse sizes are scattered about on the aboral surface especially near the base of the rays; none are very large or conspicuous. On the oral surface, a very few large forficiform pedicellariae with jaws over a millimeter long occur in, or close to the ambulacral furrows, near the mouth, and a number of small ones are present on the restricted actinal intermediate areas; distally there are virtually no pedicellariae.

Color in life variegated brown and blue; the brown has a gray tinge and the blue has a slight tendency towards green, but the large marginal spines are a very bright blue; madreporite pale brown or yellowish. The colors are very fugacious and dry specimens have lost all their beauty. In a specimen larger than the holotype, the large aboral and marginal spines are quite red in contrast to the general museum color.

Holotype, M. C. Z. no. 3362, from Lord Howe Island, April, 1932.

This handsome sea-star is one of our most interesting discoveries at Lord Howe. It lives with and like *Coscinasterias calamaria* on the reef flat near low tide level, under and among fragments of coral rock. It passes easily for a 7-armed form of that species, with unusually blue coloration. It is closely related to *A. rodolphi* of the Kermadecs with which it agrees in the scarcity of pedicellariae but it is readily distinguished from that species by its more open skeleton and fewer spines; thus in *rodolphi*, 20 mm. of the carinal ridge or of the inferomarginal plates includes about a dozen plates while in *insularis* only about 8 will be included; again in *rodolphi* the adambulacral and inferomarginal spines have much wider and more expanded tips than in *insularis*; most important of all, is that the dorsolaterals in *rodolphi* are far better developed than in *insularis* of the same size, being more numerous, larger and stouter and more generally spine-bearing. From *scabra* of New Zealand, *insularis* is much more obviously different; the fewer pedicellariae, of all sorts, the much larger spines, the much better developed spiniferous actinal plates (almost or quite wanting in *scabra* with R = 75 mm. or less), combine to give the Lord Howe species a very different facies. From the Astrostoles of the eastern Pacific, *platei* and *paschae*, *insularis* is easily distinguished by the number and form of the rays and accompanying details of spinulation and pedicellariae. Perhaps I may well add here that in my description of *paschae* (1920, p. 105) I have made the mistake of interpreting the actinal spiniferous plates as being actinal lobes of the inferomarginals, and have stated that there are 3 inferomarginal spines in each series; actually the arrangement is as described above for *insularis*.

Besides the holotype which is a small adult, there are at hand 3 paratypes. One of these is an apparently mature but somewhat asymmetrical adult, with R ranging from 70 to 110 mm. The dorsolateral series are much better developed on the basal part of the arm and the inferomarginal spines are much wider at tip, where they are also more or less channeled; the superomarginal spines have also taken on the same character. The madreporite is big and divided into a larger and a smaller part but they are in close contact. The outer series of adambulacral spines has the tips noticeably widened, though not quite so much so as in *rodolphi*. Pedicellariae, as in the holotype, conspicuous by their absence! A second specimen is a young individual with R = 35 mm. The dorsolaterals are small and very rarely spiniferous. The other aboral spines are relatively very large. There is no trace of an actinal series of plates and hence only 2 spines occur in connection with each inferomarginal plate. Pedicellariae are even more infrequent than in the adults. The third specimen is a freak; it consists of a disk about 13 mm. in diameter and one arm about 50 mm. long. Growing out from the disk are 6 very young arms, with their lengths ranging from 8 to 16 mm. Apparently an Astrostole with 7 normal arms 50 mm. long lost 6 of them (whether autotomously or not, who can say?) and was replacing them by typical regeneration when the specimen was taken.

ALLOSTICHASTER POLYPLAX

Asteracanthion polyplax MÜLLER and TROSCHEL, 1844. Arch. f. Naturg., **10** (1), p. 178.
Allostichaster polyplax VERRILL, 1914. Harriman Alaska Exp. Starfishes, p. 363.

This is one of the few sea-stars common to New Zealand and Australia. Its range, like that of *Coscinasterias calamaria*, extends from New Zealand, New South Wales and Tasmania westward to Rottnest Island. Unlike *calamaria* however, *polyplax* does not occur at Lord Howe, at least it has not yet been found there. Comparison of individuals of the same size from New South Wales, South Australia and Western Australia show no character or trend to indicate more than a single form. Judging from the small series of specimens at hand, in South Australia 95% of the specimens which are not the result of recent autotomy have 8 arms; in Western Australia, 90%; in New South Wales, 81%; and in

Tasmania, only 77%. But I do not see any taxonomic significance in these figures even supposing large series of specimens showed them to be reliable.

My field notes on this secretive little sea-star may be of some interest. While at Perth, I wrote: "Not common, but found at Rottnest and at Point Peron — color in life brown with a markedly greenish cast, cream-color underneath. Colors very fugacious and specimens become yellowish with more or less orange mottling on death, and even these shades change or disappear." At Bunbury, I noted that the color was "light greenish-brown becoming more orange-brown along ray-margins." At Port Willunga, S. A., my notes say it is "quite common. All (?) have 8 arms; browner than those on west coast, not so evidently green. One large specimen quite different as it was an orange-brown, not at all bright however, but with no hint of olive or green." At Hobart, I found that *polyplax* was common; "color usually brownish and red but some are greenish as at Perth and Port Willunga. The small specimens have red more evident than in adults. Common in dredge hauls, on or in shells, crannies of any sort."

The present series of 106 specimens contains many part-specimens for autotomy is repeated constantly, and perfectly symmetrical specimens are rarely seen; these commonly have R = 20 mm. or more. The smallest specimen at hand has 3 arms, each about 8 mm. long; the broken surface has healed but no new arms have begun to bud. In the same lot is a little sea-star with 2 arms, side by side, 10 mm. long and 6 arms opposite to them each about 5 mm. long. Specimens with 7 arms are rare, but one from Hobart has 5, 18 mm. long and 2, 15 mm., while another from the same place has 4 large (12–13 mm.) and 3 small (8 mm.) arms. The largest specimens are from Bottle and Glass Rocks, Port Jackson; the largest of these has, on one side, 4 arms with R = 36 mm. and opposite to them are 4 with R = 12–15 mm. Of these Port Jackson specimens, 4 of maximum size, have 4 (or 3) large and 4 (or 5) small arms, indicating that asexual reproduction by autotomy continues long after maturity is reached.

The 106 specimens of *polyplax* at hand come from the following places:

New South Wales: Colloroy, Long Reef, November 28, 1929. 3 specimens.
Port Jackson, Bottle and Glass Rocks, November 27, 1929. 5 specimens, including several large adults.
Shell Harbor, May 4, 1932. 8 specimens.

Tasmania: Hobart, estuary of Derwent, November 15, 1929. 27 specimens; adult and young.

South Australia: Port Willunga, November 2, 1929. 28 specimens, mostly small adults.

Western Australia: Middleton Beach, Albany, January, 1929. E. W. Bennett leg. et don. 5 specimens.
Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 23 specimens.
Bunbury, October 25, 1929. 1 specimen.
Point Peron, October, 1929. 1 specimen.
Rockingham, Cymodocea beds, 4–5 feet of water, February 7, 1932. E. W. Bennett leg. et don. 1 small specimen.
Rottnest Island, October 19, 1929. 2 specimens.
Cottesloe Beach, E. W. Bennett leg. et don. 2 small 7-rayed specimens.

SMILASTERIAS IRREGULARIS

H. L. CLARK, 1928. Rec. S. Austral. Mus., **3**, p. 402.

Among the interesting echinoderms which were loaned by the National Museum at Melbourne is a symmetrical pentamerous sea-star of small size which may be considered the second known specimen of this species. The identification is by no means assured but as the holotype was nearly twice as large as the present specimen (in which R = 25 mm., and br 5 mm.), too exact a correspondence should not be expected. Certainly in the characters of the oral surface, the identity is very close. The chief unlikeness is in the character of the aboral skeleton, which is delicate, with regularly arranged longitudinal series of papular areas, wider than long. Until more and better material is available, it seems better to call this Victorian specimen *irregularis* than attempt to differentiate it as a new species. If the type of *irregularis* were at hand for comparison, the question might be settled satisfactorily but as it is in Adelaide, my Australian colleagues must do the comparing. The present specimen was taken at San Remo, Westernport, Victoria by Mr. G. Coghill, January 28, 1909.

I may be permitted to add that there are in the M. C. Z. collection a number of small asteroids, in poor condition, which were dredged at Westernport and in Port Philip by Mr. J. Gabriel, who presented them to us, with other unidentified material, in 1915. Some of these are large enough and in good enough condition to assure their identity with the specimen from San Remo but they make me even more doubtful whether that specimen is really *irregularis* and not rather a distinct species. For the present, the matter must be left in this unsatisfactory condition.

UNIOPHORA GRANIFERA

Asterias granifera LAMARCK, 1816. Anim. s. Vert., **2**, p. 560.
Uniophora granifera BELL, 1881. Proc. Zool. Soc. London, p. 497.

It was disappointing not to find Uniophora at either Port Willunga or Hobart, but that failure gave an added thrill to finding a specimen at Bottle and Glass Rocks, Port Jackson, November 27, 1929, when Mr. Melbourne Ward took me there for a morning's collecting. This individual was a bright, deep carmine in life, shaded on depressed areas with dusky. It is now light brown with the spherical tubercles of all sizes very light, almost a brownish-white. It has R = 55 mm. and r = 14; hence R = 4r. As a typical example of the species, it is very satisfactory but as the species was already well known from Port Jackson, it naturally throws no light on the distribution or taxonomy of this still imperfectly known genus.

OPHIUROIDEA

The collection of ophiurans contains 3482 specimens representing 45 genera and 132 species. Of the genera 7 are new but nearly half of them are the result of segregation from the big unwieldy genus Ophiothrix, 3 fairly well-defined groups. The remaining species listed under Ophiothrix are a heterogeneous group which needs further study and subdivision. Of the 4 genera, actually new morphologically, it is interesting to note that 2 are from Lord Howe Island (though one occurs also on the Queensland coast) one is from the historic Port Essington and one is from Broome.

Of the 132 species no fewer than 54 are undescribed. This seems like an unreasonably high percentage of novelties but when one considers the richness and diversity of the Australian fauna and how little attention the ophiurans have received, it is not so surprising. That there are 14 species to be added to the already unwieldy genus Amphiura is to be regretted and emphasizes not only the ubiquity of the group but the sore necessity for its prompt and careful revision. It is remarkable that so many Amphiuras occur while only one Amphipholis and one Amphiodia were taken, and each is a wide-ranging species.

The new genera are:

OPHIOTHAUMA, type *heptactis* sp. nov. Monotypic.
AMPHISTIGMA, type *minuta* sp. nov. Monotypic.
LISSOPHIOTHRIX, type *delicata* sp. nov. Monotypic.

Macrophiothrix, type *Ophiura longipeda* Lamarck. 21 species.

Placophiothrix, type *Ophiothrix melanosticta* Grube. 8 species.

Ophiodyscrita, type *acosmeta* sp. nov. Monotypic.

Ophioteichus, type *parvispinum* sp. nov. 2 species.

The 54 new species, belong to only 25 genera. They are as follows, the type locality being also shown.

Euryale euopla	W. A.: "Bald Island, east of Albany."
Astroconus occidentalis	W. A.: "North Beach near Perth."
Astrocladus granulatus	Q.: Lindeman Island near Mackay.
Ophiacantha ameleta	Celebes; Siboga Sta. no. 117.
tenuispina	Q.: Port Curtis
Ophiothauma heptactis	N. T.: Coburg Peninsula, Port Essington.
Amphiura acrisia	W. A.: Broome
bidentata	W. A.: Broome
brachyactis	W. A.: Broome
cataphes	N. S. W.: Port Jackson
diacritica	Q.: Whitsunday Passage
dolia	N. S. W.: Port Jackson
leucaspis	W. A.: Lagrange Bay
magnisquama	N. S. W.: off Botany, 33–56 fms.
micra	W. A.: Broome
multiremula	N. S. W.: Colloroy, Long Reef
nannodes	W. A.: Rottnest Island
phrixa	W. A.: Broome
ptena	W. A.: Bunkers Bay
stictacantha	W. A.: Broome
Ophiocentrus fragilis	N. S. W.: off Port Jackson, 120 fms.
Ophionephthys decacantha	W. A.: Broome
tenuis	W. A.: Broome
Amphistigma minuta	Lord Howe Island
Amphioplus didymus	W. A.: Broome
stenaspis	N. T.: Darwin
Ophiactis acosmeta	W. A.: Dongarra
brevis	N. T.: Darwin
fuscolineata	W. A.: Broome
laevis	W. A.: Bunbury
Lissophiothrix delicata	W. A.: Broome

Macrophiothrix callizona	W. A.: Broome
calyptaspis	W. A.: Broome
lampra	N. S. W.: Port Jackson
scotia	W. A.: Broome
spinifera	W. A.: Broome
Ophiotrichoides irregularis	Q.: Port Curtis
pulchra	W. A.: Broome
Placophiothrix albolineata	Lord Howe Island
Ophiogymna lineata	Q.: west of Low Islands, 6–8 fms.
Ophionereis hexactis	N. T.: Darwin
stigma	W. A.: Cape Leveque
tigris	Q.: Northwest Islet
Ophiocoma occidentalis	W. A.: Point Peron
Ophiomastix notabilis	W. A.: Cape Leveque
Ophiarachna megacantha	Q.: off Double Island Point, 33 fms.
Pectinura nigra	W. A.: Bunbury
Ophiarachnella paucigranula	Q.: off North Direction Island, 19 fms.
rugosa	W. A.: Broome
Cryptopelta callista	W. A.: Broome
Ophiodyscrita acosmeta	W. A.: Broome
Ophioteichus multispinum	Q.: Lindeman Island
parvispinum	Lord Howe Island
Ophiolepis unicolor	W. A.: Broome

In several cases, varieties have required recognition; of these the following 5 are here named for the first time.

Ophiactis savignyi var. *lutea*	N. T.: Quail Island
Ophionereis semoni var. *nigra*	W. A.: Point Peron
var. *badia*	W. A.: Dongarra
Ophiurodon cinctum var. *pulchellum*	W. A.: Cape Leveque
Ophiarachnella ramsayi var. *pulchra*	W. A.: Rottnest Island

As shown by the above list Lord Howe Island is the home of only 3 of the new species but 2 of those represent new genera. The coast of Queensland furnishes type localities for 9 species and that of New South Wales for 6. From the Northern Territory, there are 4 species and a variety, while the coasts of Western Australia are the home of 31 new species and 4 new varieties of which no fewer than 20 claim Broome for their type locality.

Brittle-stars are obviously the most abundant echinoderms of the Australian coast. Owing to the small size and secretive nature of many species they are easily overlooked and the average collector who is not interested in the group never realizes how many are passed over. The larger forms such as the more common species of the Ophiocomidae, Ophiodermatidae and Ophiotrichidae living as they do under rock fragments or among corals, and being more or less active in their movements, attract the attention of most "along-shore" collectors, but they make up only about one-fourth of Australia's ophiuran fauna. Naturally conditions at Broome, so favorable for sea-stars are equally suitable for brittle-stars, and about one-half of the 132 species in the following account were taken in the Broome region. Of course the Barrier Reef area is abundantly populated with ophiuroids but as we did no collecting there the following list gives a very inadequate idea of that fauna. On the southern coast of the continent brittle-stars are much less abundant than in the tropics but some very interesting forms occur there; that fauna is of course quite inadequately represented in the present collection. Western Australia between Geraldton and Albany has a large and varied ophiuran population well represented in our collection by some 30 species, of which about one-fourth are here described for the first time.

Brittle-stars occur under the most diverse environmental conditions. Many are to be found only among corals, particularly the gorgonians, and large sponges, especially those with a branching habit, often carry great numbers of ophiurans especially of the genera Ophiactis and Ophiothrix (and its allies). Curiously enough certain sponges are completely free from ophiurans, presumably because of some secretion obnoxious to the echinoderms. Very few ophiurans, except the multibrachiate forms like Euryale, live exposed freely on the sea-bottom. Some live buried just below the surface on sandy bottoms, while others have become adapted to a subterranean life and are found only deeply buried in sand or even in mud. Such forms have in many cases become strikingly adapted to such a life, an increase in the length of arms and a decrease in the calcareous matter covering the body being frequent. But the best hunting ground for brittle-stars is among corals and coralline algae, particularly in the dead basal portions, and under rock and coral fragments in such areas. Many small forms can be secured only by placing quantities of such material in pails or basins with just enough sea-water to cover it. With the passage of a few hours, the oxygen in the water apparently becomes deficient and all the small animals come out of their hiding places and are easily secured by the collector.

The literature dealing with Australian ophiurans is not extensive. Lyman's (1882) great work on the "Challenger" Ophiuroidea is of course absolutely essential. Koehler's various reports are invaluable particularly those on the "Siboga" littoral ophiurans (1905), on the Ophiuroidea taken by Michaelsen and Hartmeyer in Western Australia (1907), the "Albatross" Philippine material (1922) and on Mortensen's great collections (1930). Döderlein's works on the Euryalids (1911, 1927) are essential for that group. Bell's report on the "Alert" echinoderms (1884) cannot be ignored and my various reports on Australian collections (1909, 1914, 1916, 1921, 1923 and 1928) contain considerable additional material. The death of Koehler in 1931 was a great blow to all students of Echinoderms and it is to be regretted that at the present moment there is no outstanding student of the Ophiuroidea.

In collecting brittle-stars, little care need be used except in the case of the long-armed Amphiuridae. These have a deplorable habit, especially if they are fully mature sexually, of shedding the disk, and of course if this happens in the dredge, the chances of its recovery are small. If it is psssible to handle the animals carefully from the time they are first discovered, shedding of the disk is very rare. The breaking of the arms is of course the most frequent mishap; with dredged material it is very general except in the forms with short stout arms and even here it is frequent. The only remedy is great care in handling. Some species resent any handling and break off the arms on the slightest provocation, but this is rare. Brittle-stars are very easily affected by Epsom salts ($MgSO_4$) and once they are completely narcotized can be handled with impunity; if they are to be dried after killing the arms should be arranged while still flexible in whatever position they are desired. With specimens of considerable size, it is a convenience to have the arms arranged, as far as possible, parallel to each other all pointing in one direction. In methods of killing and preservation, brittle-stars may be treated like small sea-stars (see p. 60) but it is an interesting fact that their colors (excepting bright reds) are much less fugacious than in the Asteroidea. Many brittle-stars keep their colors very well in alcohol, and color patterns are very generally retained. In formalin the colors usually are altered but little but the specimens themselves are quickly damaged and often ruined by the action of the fluid on the tissues. Consequently it is better not to leave brittle-stars in formalin more than a few hours at the most.

OPHIOMYXIDAE

OPHIOMYXA AUSTRALIS

Plate 13, figs. 1–2

LUTKEN, 1869. Add. ad Hist. Oph., pt. 3, p. 45.

This active brittle-star was met with at Lord Howe Island but was not common, only 2 specimens being seen. They were found hidden in crannies in the coral at Ned's Beach, and are about half grown; disk, 15 mm. in diameter, arms, some 80 mm. long. In life one was "red brown with a purplish cast above, darkest on disk, rather light on distal part of arms; scattered gray flecks on disk; 5 or 6 narrow, gray bands on arms, faint and widely spaced, most evident distally; lower surface of arms flesh-red." The other specimen was "olive, yellow-brown and yellow; lower surface of arms, yellow-brown; gray flecks on disk and variegation on arms; no definite bands; no red." In their present dry condition, the first specimen is deep brown above, with gray flecks and markings evident; a red tint is still visible on lower surface of arms; arm-spines tend to be very light, almost white on distal half of arms. The second specimen is a lighter, more olive, brown and of course shows no trace of red.

A small brittle-star with disk 6 mm. across and arms all broken, found in "a conglomerate boulder, taken by trawler "Goonamba," about lat. 33° 44′ S., long. 151° 88′ E. (about 16–18 miles northeast of South Head, Port Jackson, about 15 miles from land), 75–80 fms., May, 1924" and presented to the Australian Museum by C. W. Mulvey, is apparently a young Ophiomyxa, but it is in too poor condition to permit positive identification.

The National Museum at Melbourne has kindly loaned an Ophiomyxa "dredged in Port Phillip by J. A. Kershaw," which is a young example of *australis* with disk about 12 mm. across.

At Port Willunga, South Australia, I secured a very large adult of this species, the largest I have ever seen. The disk was about 35 mm. across and the arms 140 mm. long or more; in its present dried condition the disk exceeds 30 mm. In life it was "deep olive green above, dull flesh-red and orange (rather brightly colored) beneath, especially around mouth; arms indefinitely banded light and dark distally." We did not meet with Ophiomyxa at any point on the Western Australian coast nor has it been included in any of Professor Bennett's collections.

TRICHASTERIDAE

ASTROBRACHION ADHAERENS

Ophiocreas adhaerens STUDER, 1884. Abh. K. Preuss. Akad. Wiss. Berlin, p. 54.

Mr. Melbourne Ward has kindly sent me a very fine specimen of a young simple-armed trichasterid which he dredged in 9 fms. in Whitsunday Passage, off Lindeman Island, Queensland. It measures 6 mm. across the disk and the much coiled and twisted arms are well over 100 mm. long. The color is a rather bright yellowish-brown. Comparison with a cotype of Studer's species (which specimen, by the way, has 6 arms, but only 5 jaws) of about the same size fails to reveal any point of difference to which weight can be given. Comparison with a cotype of *Ophiocreas phanerum* H. L. C. is of no value, the specimen of *phanerum* being so large no real comparison is possible. I am inclined to agree with Mortensen (1924, p. 99–101) that *phanerum* and *constrictum* Farquhar are identical and both probably synonyms of Studer's *adhaerens*. But a good series of specimens from 6–18 mm. in disk diameter will be needed before we can feel sure of the matter. Döderlein's establishment of the genus Astrobrachion for these forms seems justifiable.

A very small Astrobrachion with disk only 2 mm. in diameter and arms 20–30 mm. long, belonging to the Australian Museum, may properly be assigned to this species for the present. It was taken in 15 fms. at Port Molle, Queensland.

EURYALE[1] ASPERA

LAMARCK, 1816. Anim. s. Vert., **2**, p. 538.

The tropical coasts of Australia seem to be a congenial home for this remarkable "basket-fish" which ranges as far south as Double-Island Point on the Queensland Coast and at least as far as Cape Villaret in Western Australia. It is apparently not common at Darwin as a single small individual dredged there near the Leper Station, May 25, 1932, was the only one we secured; it is now (dry) 3 mm. across the disk and has arms 15–20 mm. long, which branch 5–7 times. It is somewhat more pigmented than similar small specimens from Broome, but it was taken on a bottom more or less covered with coralline algae, sponges, etc., very different from the habitat at Broome, where all of the very young individuals taken were living on gorgonians while the adults live free and unprotected on the hard sand bottom. The young are pure white at first; then the disk and basal part of arms show a reddish tinge and the tips of the big spines on the distal ends of the radial shields are quite pink. Later, when disk is 6–10 mm. across, red-purple pigment becomes conspicuous around the margins of the disk and in irregular patches on the arms. Many adults still retain a more or less purple color but there is great diversity. My field notes at Broome say: "dark wine-red or brownish-red, disk more purple than arms;" "dull yellowish disk, rose-color on basal part of some arms; "fawn-brown, variegated;" "usually considerable reddish orally;" "dark grayish with no trace of red or purple." The adults are 25–40 mm. across the disk while the arms range up to at least 250 mm. In well prepared specimens, the length of the arms is 6–8 times the disk diameter. It is not unlikely therefore that living adults have a feeding area 500–600 mm. across. One specimen from Broome is perfectly tetramerous the disk being a square with sides, 12–13 mm. long.

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[1] I cannot agree with Döderlein's (1911, p. 9, 10) line of reasoning which necessitates calling this genus Euryala. The names Euryale, Gorgonocephalus and Astrophyton were never truly synonymous. None was a monotypic group or had a type designated. Lyman as first reviser in 1880 was quite within his rights in delimiting the groups as he did and it is unnecessary to alter the names.

The 40 specimens at hand are from the following localities:

Queensland: Port Curtis. 1 specimen, very young but well pigmented. Loaned by Australian Museum.
Lindeman Island, July-September, 1934. 10 specimens, very young. Melbourne Ward leg. et don.
Northern Territory: Darwin, dredged near Leper Station, May 25, 1932. 1 very young specimen.
Western Australia: Broome, August and September, 1929. 13 specimens, adults.
Broome, June, 1932. 15 specimens, very young and adult.

Euryale euopla[1] sp. nov.

Plate 23, fig. 1

Similar to *aspera* in its general structure and characters, but with much heavier and coarser spines on the disk and proximal arm divisions. The first fork of the arms is distinctly further from the margin of the disk than in adult *aspera* and apparently there are fewer subsequent divisions; owing to the condition of the specimens, which are dry, it is impossible to reach a positive conclusion on this point. In large specimens of *aspera,* the first fork is about 8–15 mm. from the ends of the radial shields; in the specimens of *euopla,* it is 15–30 mm. In *aspera,* when the disk and arm spiniform tubercles are unusually large, they may measure as much as 4 mm. high and 1.5 mm. in diameter at the base, the tip being smaller and often sharp-pointed. In *euopla,* these spiniform tubercles are often 5–7 mm. long, 2 mm. or more in thickness and blunt or markedly clavate at tip. The number of these clumsy-looking spines is undoubtedly fewer than in *aspera* but it is difficult to put the difference into figures; it is probably safe to say that in specimens of the same size there are not more than two-thirds as many in *euopla* as in *aspera.*

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[1] εὔοπλος = *well-armed*, in reference to the very heavy spinulation of disk and basal part of arms.

Holotype, Western Australian Mus. no. 9683, from Bald Island, east of Albany, W. A.

There are two specimens of this striking Euryalid, which agree in all essentials. Both are yellow-brown in color with the center and interradial areas of the disk considerably darker than the radial shields and the sides of the arms. They were taken, apparently at the same time and place. The holotype is 30 mm. across the disk and 10–12 mm. across the base of each arm which fork at least 6 or 7 times, and probably 8 or 9. The paratype is 25 mm. across the disk and the base of each arm is 8–10 mm. wide.

The occurrence of Euryale on the southern coast of Western Australia is most surprising, as no specimen of the genus has hitherto been reported from south of lat. 20° on the west coast and 26° on the east. It is hard to believe that there is not some mistake about the locality label, but in any case there is little question that these two specimens should not be referred to the widespread species *aspera.* It is not incredible that they are extreme representatives of that form but until connecting links are found the name *euopla* may well be used for them.

GORGONOCEPHALIDAE

ASTEROPORPA AUSTRALIENSIS

H. L. CLARK, 1909. Mem. Austral. Mus., **4**, p. 547.

There are 10 nice examples of this species at hand, presented by the Australian Museum, ranging in disk diameter from 5 to 17 mm. They were trawled in 70–75 fms. of water, off Cape Everard, Victoria, March 6, 1929.

ASTROCONUS AUSTRALIS

Astrophyton australe VERRILL, 1876. Bull. U. S. Nat. Mus., **3**, p. 74.
Astroconus australis DÖDERLEIN, 1911. Abh. Math.-phys. Klasse K. Bayer. Akad. Wiss., II Suppl. Abh. 5, p. 37.

There is at hand an interesting young but quite typical example of this characteristic Australian species loaned by the Australian Museum. It is the smallest specimen on record, only 6 mm. across the disk, with arms 20–25 mm. long. The general tint is cream-color but there are light brown marks on the disk and rings on the arms of the same shade. The label reads: "On brown sea-weed (on hook and line), Banks Strait, off Flinders Island, N. E. Tasmania, 7 fms."

ASTROCONUS OCCIDENTALIS[1] sp. nov.

Plate **23**, fig. 2

Disk 32 mm. in diameter, with 5 arms exceeding 100 mm. in length, forking at least half a dozen times and probably more; width of arm at base about 10 mm., its height about one-half as much. Disk mostly covered by 5 radiating wedges, between which in the interradii are narrow sunken areas; each wedge consists of two indefinitely outlined radial shields only slightly separated from each other by a shallow depression, broadest distally. Wedges covered by a pavement of circular or elliptical flat plates, half a millimeter in diameter or less, surrounded by and mixed with, granules or small plates of diverse size — many extremely small; distal portion of wedges and interradial areas between covered by small plates and granules, the difference being that the plates are flat, the granules more or less hemispherical; the plates are not numerous enough anywhere to form a smooth pavement. Scattered all over the disk, quite irregularly in the interradial "valleys" as well as on the radiating wedges are scores of more or less bluntly conical tubercles, the largest of which are 1.5 mm. in diameter and almost as high, but there is great diversity in size; they are not smooth but finely ridged and wrinkled in an irregular way. On the distal end of each wedge the tubercles become more uniform in size and arrangement; they are a millimeter in diameter or less and arranged in 3 or 4 transverse series forming ridges separated from each other by rather deep valleys. These tubercled ridges continue out on the arm; there are only 2 or 3 before the arm forks about 5 mm. from the disk.

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[1] *occidentalis* = western, in reference to its being the representative of the genus on the western coast of Australia.

On the arms from the first fork to the second or third or a little further on some branches, the tubercled ridges continue as incomplete rings on the top and sides of the arm; at first there are 10–15 tubercles on each ring but the number decreases distally and they disappear near the middle of the arm, though the rings themselves continue far out and can be distinguished almost to the very tip of the arm. Between the ridges is a fine but not smooth coating of minute plates and granules.

Entire lower surface covered by a fine, granular coat, coarsest in the interradial areas. Tentacle pores small; first pair well within disk, with no tentacle-scales. Each succeeding pore is more or less concealed by a slight ridge on its adoral side, which carries 5 or 4, short peg-like, flattened spines, terminating in 3 long, glassy teeth or thorns; the ridges themselves merge into the tubercled ridges of the upper surface and sides of the arm. Each mouth angle carries a large number of teeth and oral papillae of diverse sizes, carried irregularly on the sides as well as at the tip of the jaw. Genital slits about 4 mm. long, near the upper margin of the interbrachial area, on each side, close to the arm. Madreporic plate single, well defined, close to the mouth frame in one interradial area.

Color purplish-brown lightest on tubercles and ridges, the valleys and depressions contrastingly darker; there are also irregular dark markings on the disk. Orally the contrast between light and dark is conspicuous; the interbrachial areas, mouth frame and arm bases are brownish yellow with dull purple markings; on the arms these purple markings are short transverse bars, arranged regularly along each side but the regularity of arrangement disappears after the first fork.

Holotype, Western Australian Museum no. 116–37, from North Beach, near Fremantle, W. A.

This is a very notable gorgonocephalid obviously related to *Astroconus australis* but easily distinguished by the regular tuberculated ridges on the arms, which give it a very distinctive facies. Presumably it replaces *australis* on the western coast of the continent.

ASTROCLADUS GRANULATUS[1] sp. nov.

Plate 23, fig. 3

Disk 11 mm. in diameter; arms 35 mm. or more in length, branching 8–10 times; first fork about 4 mm. from disk margin at distal ends of radial shields;

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[1] *granulatus* = roughened by granular elevations, in reference to the granular surface of the disk.

arm 3 mm. wide before forking. Disk decagonal, with 5 concave interradial sides, and 5 nearly straight sides where arm bases are in contact with radial shields; latter about 5 mm. long by 1.5–1.75 mm. wide, nearly parallel in pairs, strongly convex but not at all sharply defined; interradial areas slightly, center of disk markedly, depressed in the dry specimen. Whole surface of disk covered with a nearly uniform, but not at all crowded, coat of rounded granules, coarsest on radial shields, finest at center of disk.

Arms evenly covered on dorsal surface and sides with a nearly uniform granulation like that of the disk, coarsest near base of arm and becoming more and more fine distally; on the distalmost branches, alternating rings of coarser and finer granulation can be distinguished but they are ill-defined and can scarcely be made out until after the fifth or sixth fork of the arm.

Whole lower surface covered with a fine, low granulation. Tentacle pores very small, with 6 pairs before the first fork of the arm. Tentacle scales are found between the first and second forkings of the arm; at first there are 2 or sometimes 3, but distally there are more commonly 3; they are very small and their bases scarcely form a distinguishable ridge, while the glassy thorns at the tip are very minute. On the distalmost branches, the tentacle scales are relatively much larger making the tips of the arms very rough in the dry specimen — no doubt very "sticky" and clinging in life. Madreporite single, small, wider than long, on the soft interbrachial area just outside the mouth frame. Each mouth angle occupied by a group of teeth, dental papillae and oral papillae, not sharply distinguishable but much smaller distally than at the center of mouth.

Color uniformly rich red-brown; there is no clue to the color in life.

Holotype, M. C. Z. no. 4899, from Lindeman Island, Great Barrier Reef, Queensland. July-September, 1934. Melbourne Ward leg. et don.

This seems to be a very well marked species characterized by the granular covering without tubercles or spines and the very smooth oral surface without any tentacle scales until after the first arm fork. Besides the holotype, there is at hand a very small gorgonocephalid, with disk only 5–6 mm. across, which Mr. Ward dredged in 9 fms. off Lindeman Island in 1929, and gave to the Australian Museum. This specimen is very pale cream-color, the radial shields are conspicuous in parallel pairs and the granulation is very fine, but I think there is no doubt it is a young individual of *granulatus*.

ASTROCHALCIS TUBERCULOSUS

KOEHLER, 1905. "Siboga" Oph. Litt., p. 130.

A huge gorgonocephalid in the Australian Museum (J 5294) is certainly an Astrochalcis and probably represents this species; but it is strongly contracted, the arms being rolled inward so as to completely conceal the oral surface, and is now very dry, so that any real study of the specimen is impossible without wrecking it. It is fully 75 mm. across the disk and the arms are 30 mm. wide at base. The ground color is a light purplish-brown but it is irregularly spotted and marked with a dirty cream-color and the arms distally become the same tint. The plating of disk and arms is quite smooth but there are rather numerous tubercles, which are so low as to be mere convexities, 1.5–3 mm. across.

This specimen was taken in September, 1928, in Albany Passage, northern Queensland, on a gravelly bank, in 9–12 fms.

OPHIACANTHIDAE

OPHIACANTHA CLAVIGERA

KOEHLER, 1907. Fauna Südwest-Australiens: Oph., p. 247.

In Koombana Bay, Bunbury, W. A., one of the original localities for this species, we took 11 specimens, October 26, 1929. The largest is 3.5 mm. across the disk and hence is much larger than any of Koehler's 7 specimens; the arms are about 14 mm. long. The smallest specimen is only 1 mm. across the disk. Growth changes in this species are remarkable, for the disk spinelets tipped with 2 or 3 glassy teeth gradually lose those tips and become changed into little sugar-loaf shaped tubercles. In the largest specimen the uppermost arm-spine at base of arm is not merely clavate but is actually forked at tip. The color of *clavigera* ranges from indistinctive light brownish to white, but the distal ends of the radial shields are rather conspicuously white.

At Broome in June 1932, a small ophiacanthid was dredged which it seems best to refer to this species. As the disk is only 2 mm. across and the arms 12–14 mm. long, it is obviously too young for certain identification, but the general appearance, the disk covering, the white-tipped radial shields, and the arm-spines are much like those of *clavigera*. As this species has been taken in Cockburn Sound near Fremantle, the occurrence in the vicinity of Broome would indicate a distribution coinciding with that of some other Western Australian echinoderms.

OPHIACANTHA DISCOIDEA

LYMAN, 1879. Bull. M. C. Z., **6**, p. 57.

The Australian Museum loaned 2 unidentified Ophiacanthas which prove to represent this species. One was collected at the Murray Islands in 1907 by Hedley and McCulloch while the other has no data but was probably taken at the same place. The Murray Island specimen has the disk 2.5 mm. across and is in excellent condition. The other is a trifle larger but all the arms are more or less broken. Both are dry, and bleached to a very pale brownish white.

OPHIACANTHA HETEROTYLA

H. L. CLARK, 1909. "Thetis" Ech., p. 542.

There are a number of unidentified Ophiacanthas from the Australian Museum to be referred to this species. Only one calls for any comment. It was taken by Mr. Melbourne Ward in 1929, off Gordon, D'Entrecasteaux Channel, Tasmania, in 5 fms. It is unusually large (4 mm. across the disk) and dark colored, the upper surface of disk a distinct brown, the lower surface and arms more of a gray brown; at the center of each mouth shield and of each of the first two lower arm plates is a nearly circular blackish spot with ill-defined boundaries. Some specimens from off Port Jackson show the same feature but less conspicuously; they are themselves lighter colored.

Besides the specimen from Tasmania, the material at hand consists of 17 specimens taken as follows:

New South Wales: 15 miles northeast of South Head, Port Jackson, 75–80 fms. May, 1924. C. W. Mulvey leg. et don. 4 specimens, 2 adult.

2.5–4 miles off Botany Bay, 33–56 fms. Trawler, "Goonambie." McNeil and Livingstone leg. 13 specimens, adult and young.

OPHIACANTHA AMELETA[1] sp. nov.[2]

Ophiacantha dallasii DÖDERLEIN, 1896. Denkschr. Med.-Nat. Ges. Jena, **8**, p. 291, non *Ophiacantha dallasii* DUNCAN, 1879. Jour. Linn. Soc.: Zool., **14**, p. 471.

A specimen of Ophiacantha from the Murray Islands at the northern end of the Great Barrier Reef, loaned by the Australian Museum, agrees exactly with

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[1] ἀμέλητος = *neglected*, in reference to previous confusion with *O. dallasii* Duncan.

[2] Holotype, M. C. Z. No. 3508, from 46 fms.., Kwangdang Bay, Celebes; "Siboga" St. 117.

one of the "Siboga" specimens now in the M. C. Z. Both correspond admirably with Döderlein's figures and description. But one cannot understand how the distinguished German scholar could have considered his material identical with Duncan's species from Korea. His passing over the striking difference in the arm-spines as accidental is quite unacceptable. The present species has very long slender spines, as against relatively short, thick spines in *dallasii* but more important is the presence in Döderlein's species of relatively huge spines on the second arm-segment as the uppermost of the series. Neither Döderlein nor Koehler refer to these as being limited to the second segment but in the two specimens at hand this is the most noticeable feature.

OPHIACANTHA TENUISPINA[1] sp. nov.

Disk 4.5 mm. in diameter; arms all broken but at least 15 mm. long and probably more. Disk covered with the usual coat of thin overlapping scales, normally completely hidden by the dense coat of spinules which they bear; these spinules are relatively very long and slender and, when fully developed and uninjured, bear three long divergent teeth, as long as the stem of the spinule and even more slender; these teeth are naturally very easily broken and hence many spinules seem to terminate in very short blunt teeth. Radial shields hidden but apparently long, narrow, and parallel; in one radius, there is a very narrow, apparently bare area as though the radial shield itself bore no spinules, but this was not confirmed by the other radii.

Arms not particularly slender and not really moniliform (except perhaps on the distal portions which are missing) but markedly constricted at every joint. Upper arm-plates small, triangular, wider than long, widely separated. Side arm-plates large, meeting broadly above, more narrowly below; each plate carries a series of 9 or 10 very slender and finely thorny arm-spines the upper ones longest, 3 mm. or more in length; the uppermost 4 or 5 are very similar but the lower ones decrease rapidly in length and the lowest is not very much larger than the single, flat, thorny-tipped tentacle-scale. Lower arm-plates at base of arm bell-shaped, much broader distally that at the somewhat bluntly pointed proximal end; lateral margins, concave; further out the plates become more and more triangular with a convex distal margin, and are more and more widely separated.

Oral shields triangular, wider than long, the lateral margins rounded; adoral plates longer than wide about as wide proximally, where they meet, as distally.

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[1] *tenuispinus* = having slender spines, in reference to the delicacy of both disk and arm spines.

Each jaw carries a vertical series of narrow rather blunt teeth and 3 very conspicuous, long, narrow pointed oral papillae on each side.

Color of disk, in dry specimen, light yellowish-brown, grayer on the margins so there is no sharp contrast with the dark gray arms, which are lighter orally; an ill-defined whitish spot on the disk near the base of each arm. Arm-spines glassy but with a bluish tint and faintly banded or marked with fine transverse darker lines; this pretty coloring of the arm-spines is only visible in a good light, under more or less magnification.

Holotype, Australian Museum, no. J6049, from 9–12 fms., off Gatecomb Head, Port Curtis, Queensland, July, 1929. Ward and Boardman leg.

This is a very well marked species which cannot be confused with any other of the Australian forms. Among all the Ophiacanthas described from the East Indian region there is nothing like it. The disk-covering and numerous arm-spines set it apart, but the long sharp oral papillae remind one of Lyman's *O. longidens* from the Philippines.

OPHIOTHAUMA[1] gen. nov.

Arms more than 5, capable of being pulled back together over the disk as in Ophiomyces and Ophiotholia. Disk without visible radial shields, covered with scales bearing low, bluntly pointed spinelets or high conical granules. Teeth several, wide and truncate with somewhat hyaline-margin; tooth-papillae several, narrow, thick and bluntly pointed; oral papillae along the entire side of the jaws. Oral shields, adoral plates, tentacle-scales, arm-plates and spines not peculiar, much as in Ophiacantha.

Genotype, *Ophiothauma heptactis* sp. nov.

This odd little brittle-star reminds one of Ophiomyces and Ophiotholia but there is nothing peculiar about the tentacle-scales or mouth parts. It is obviously a connecting link between those deep-water genera and the more typical ophiacanthids, and as such is of more than usual interest.

OPHIOTHAUMA HEPTACTIS[2] sp. nov.

Arms 7, of very unequal length, 10–18 mm. long; there is some indication that the shortest arms have been broken off and are regenerating. Disk 3 mm.

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[1] Ophio—, the common prefix of ophiuran genera +θᾶυμα = *a marvel, a wonder*, of obvious significance.

[2] ἐπτά = *seven* + ἀκτίς = *ray*, in reference to the number of arms.

in diameter and over 2 mm. high in its present contracted condition; owing to the folding back of the arms over it, the details of its structure are obscured, but it is obviously covered with thin, rather large scales, among which no radial shields can be detected; the scales bear high conical granules (perhaps better called low, blunt spinelets) which are rather numerous but do not form a uniform coat; apparently there may be more than one granule to a disk-scale but this is not certainly determinable. Upper arm-plates rather large, rounded pentagonal; on basal part of arm, the proximal angle is truncated and the plates are in contact for nearly half their width but near tip of arm the proximal angle is sharp and the plates are well separated.

Interbrachial areas below are naturally very narrow, covered with thin plates, but with only a few of the conical granules. Under arm-plates moderately large, longer than wide, rounded octagonal, only in contact by the proximal, shortest side; at the very tip of the arm they are not in contact. Side arm-plates of moderate size, only meeting above and below near tip of arm; each carries a series of 4 rather stout, smooth, slightly flattened, blunt spines; the two lowest are about equal and shorter than the third which is in turn shorter than the rather long uppermost; the last greatly exceeds the arm-segment. Tentacle-scale single, large, flat and somewhat pointed.

Oral shields of moderate size, oval with the narrower end inward, somewhat longer than wide; madreporite the largest with a single rather conspicuous pore. Adoral plates much longer than wide and much wider distally than proximally; they do not quite meet within and radially are separated by the small first under arm-plate. Teeth 2 or 3, far up on angle of jaw, rather wide, truncate, with a slightly hyaline margin. Dental papillae several, irregularly arranged, short, thick, narrow and blunt. Oral papillae 5 on each side of jaw, rather flat and truncate, the outermost widest. Color of dry specimen very pale brown, almost white, the disk-spinelets distinctly tawny yellow.

Holotype, M. C. Z. no. 4917, from Port Essington, Coburg Peninsula, Northern Territory.

The origin of this remarkable specimen is unfortunately obscure. It was found with specimens of *Macrophiothrix belli* in a jar in which there were no other echinoderms. It was not noted when the specimens were collected. A plausible hypothesis is that it was living symbiotically (or parasitically) on one of the big ophiurans and was placed in alcohol with them. In dying, the arms were contracted to their present unusual position and the animal fell off of its host.

AMPHIURIDAE

Amphiura ambigua

Koehler, 1905. "Siboga" Oph. Litt., p. 39.

At East Point, Darwin, at different times, 4 long-armed brittle-stars were taken from the sand under rock fragments. The light gray disks and pale yellowish, but conspicuously banded arms, gave them a more than ordinarily attractive appearance. They have retained as dried specimens much of their natural coloration. They now measure 4–6 mm. across the disks while the arms are about 10 times as much. The coloration now may be described thus: Disk pale gray, the narrow radial shields often with a dark blotch at middle; arms light yellowish with enough purple-gray upper arm-plates at intervals of 2–6 segments to give them a regularly banded appearance; arm spines whitish, more or less speckled and streaked with brown of some shade, often quite dark.

There seems no good reason to doubt that these Amphiuras are adults of Koehler's East Indian species which was based on 2 young individuals. There are only two or three particulars in which the Australian specimens differ from Koehler's description. The arms are much longer, relatively, the oral shields are blunter and wider at the inner end, and the conspicuous hooks on the arm-spines occur only on 2 spines (or often only on one) in a series, while the uppermost and lowermost spines are not so stout as represented by Koehler. These differences may properly be attributed to the difference in size, and probably in age, of the specimens concerned. Certainly they do not seem to be adequate for establishing a new species. Since 1905, Koehler has found additional specimens of *ambigua* in the "Albatross" Philippine collection (1922) and in Dr. Mortensen's East Indian collection (1930), but all were of small size. It is interesting to note that in the figure given of the Philippine specimen (1922, pl. 69, fig. 6), the brown markings on the arm-spines, so evident in the specimens from Darwin, are easily seen.

Amphiura constricta

Lyman, 1879. Bull. Mus. Comp. Zoöl., **6**, p. 22.

It is an interesting illustration of the curious inconsistencies of marine collecting that no specimens of this apparently common and widely distributed brittle-star were in the extensive collections of echinoderms in the South Australian Museum in 1928, in spite of the assiduous collecting by Dr. Verco, yet the present collection contains many specimens from the coast of Western Australia as well as from the Northern Territory, Queensland, New South Wales, Tasmania and Victoria, and it can hardly be doubted that the species occurs in South Australian waters. This circumcontinental distribution is notable as it is rare among echinoderms. The species is easily recognized from Lyman's description and figures but shows some diversity in the scaling of the disk (perhaps associated with regeneration), in the character of the arm-spines (perhaps associated with age), and in the relative length and stoutness of the arms.

The material from Port Curtis, Darwin and Broome was at first supposed (largely for geographical reasons) to represent a separate species but prolonged and repeated study has failed to justify such an idea. Adult specimens from Broome are so very similar to those from Port Jackson, that they cannot be separated even as a variety. Some of the younger specimens from the northern coast however show peculiarities in the arm-spines which are perplexing. The spines are less opaque and more glassy, with a sharp hook or lateral tooth at the tip; in one specimen from Broome this is very marked but otherwise the characters are those of *constricta*. In other specimens, one or more of the lower spines are truncate (not merely blunt) and have a minute, sharp tooth on each side. No separation of such specimens from the more typical *constricta* has proved at all satisfactory, and hence all the Australian material at hand is referred to *constricta*. Unfortunately very few of the specimens are adults; with more material it may be demonstrated that two closely allied species occur on the northern coast.

Of the present series of 114 specimens, nearly all are young, and few call for any comment. The 4 largest are 6 mm. across the disk (Lyman's type was 5 mm.) but no others exceed 5 mm. and nearly all are 2–4 mm. across. Apparently adults are more difficult to find. The specimen from Shell Harbor is interesting because although small it is the only one which gives any idea of the color in life. All the others have grayish disks and yellowish or whitish arms often banded with dusky; or they are plain "museum color," a dingy light brown. The Shell Harbor specimen has retained the general color pattern of life but it is of course somewhat faded. The disk is gray, lightly mottled with darker; dorsal side of arms similar but with a pinkish tinge; lower surface much lighter, white at mouth, pinkish on arms, with several dusky cross bands on distal part of arm; arm spines pink. In a young individual taken at Lord Howe Island, the slender whitish arms were crossed by narrow, irregularly scattered bands of bright red; in all other cases the arm bands were grayish.

The 114 specimens are from the following places:

Queensland: Port Curtis. M. Ward leg. 5 specimens, adult and young. Loaned by the Australian Museum.

New South Wales: Port Stephen. 1 young specimen. Loaned by Australian Museum.

Long Reef, November 28, 1929. 1 large adult.

Port Jackson, November 21, 1929. 2 specimens.

Botany Bay, off Towra Point, 20 ft., April, 1924. "From root of kelp." J. H. Wright don. 2 specimens, small adults. Loaned by Australian Museum.

Shell Harbor, May 4, 1932. 1 specimen.

Lord Howe Island: April, 1932. 19 specimens, all young.

Tasmania: Eagle Hawk Neck, Jan. 27, 1928. T. T. Flynn leg. et don. 5 specimens, young.

Hobart, November 15, 1929. 1 specimen, very young.

Victoria: Port Philip, dredged by J. A. Kershaw. 2 specimens, young. Loaned by Melbourne Museum.

Port Melbourne, under piles of pier. W. Kershaw leg. 11 specimens, adult and young. Loaned by Melbourne Museum.

Western Australia: Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 2 specimens, young.

Bunbury, Koombana Bay, 5–8 fms., October 26, 1929. 7 specimens, very young.

Rottnest Island, 1931. G. Bourne leg. 1 specimen, small adult.

Dongarra. E. W. Bennett leg. et don. 5 specimens, young.

Broome, August and September, 1929. 9 specimens, young and small adults.

Broome, dredged in 5–8 fms., June, 1932. 36 specimens, only 2 adult.

Northern Territory: Darwin: near Shell Islands, 2–3 fms., July, 1929. 4 specimens, young.

AMPHIURA MICROSOMA

H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 228.

Four specimens, from widely separated localities, young and in poor condition, are best treated as representatives of this little known species.

One is scarcely 3 mm. across the disk, with which are associated 2 arms, 18–20 mm. long. The disk is covered by a dark skin, in which many small scales are imbedded. Comparison with the original specimens of *microsoma* leaves no doubt that it is a young individual of that species, in spite of the fact that it was taken at Bathurst Point, Rottnest Island, W. A. It was loaned by the Perth Museum.

The other 3 specimens are of about the same size, and the arms, though broken off, are still with the bodies. There are no data with 2 of these specimens, which belong to the Australian Museum, but it is quite possible that they are from the type locality, the Murray Islands. The third one is from Broome and has much broader radial shields than the other two. All three differ markedly from the Rottnest specimen and from the types of *microsoma* in having the disk covered with very fine scales. It seems to me quite possible however that this is merely a youthful character retained longer than in the Rottnest Island specimen. At any rate, it seems better to treat them as young *microsoma* than to endeavor to distinguish them as a separate species on the basis of such material.

AMPHIURA VELOX

KOEHLER, 1910. Abh. Senckenb. Naturf. Gesell., **33**, p. 292.

It is interesting to record this fine species from the northwestern coast of Australia. In June, 1932, 2 specimens were dredged in Lagrange Bay in 5–7 fms. One is badly damaged but the other is a perfect specimen. Both are somewhat larger than the type. In life the interbrachial areas are somewhat swollen and pushed out between the arm-bases, the whole disk being covered above and below with a soft skin bearing a coat of very small scales; on drying, the skin wrinkles as it shrinks but the five pairs of long radial shields tend to prevent wrinkles forming on the disk and hold the radial areas out as lobes over the arm bases; there are interradial notches between these lobes as well as in the mid-radial line between the radial shields. In the dry specimens the disk is thus flat and 5-lobed, quite different at first sight from Koehler's figure which was no doubt made from an alcoholic specimen. In all other respects, particularly the arm-spines, the oral shields and the tentacle-scales, the Australian material is just like the Aru Island specimen.

Koehler makes no reference to color so it may be well to record the color of the perfect specimen at hand. Disk, pale gray, arms pale cream-color or almost white; many upper arm-plates pale olive-gray or marked therewith; distally these plates are in groups so that the arm appears distinctly but indefinitely banded.

Aside from the six arms, this Amphiura may be recognized by the very fine scaling of the disk on both sides, the long narrow radial shields, the single large tentacle-scale and particularly by the 4 or 5 arm-spines, of which the middle pair are very characteristic.

The number of arms is evidently not a constant species character for there is at hand an individual with 5 equal arms and pentamerous in every normal way. That it is identical with the hexamerous specimens admits of no doubt. It has the disk 5 mm. across and the arms about 40 mm. long. Placed side by side with the 2 hexamerous specimens from Lagrange Bay, it shows surprising agreement in every detail of structure and color. There are however some indications that it was marked in life on both disk and arms with rusty-red, which has now almost wholly disappeared. This unique specimen was found among rocks and sponges brought up by our diver, Wan, from off North Head, near Beagle Bay.

AMPHIURA ACRISIA[1] sp. nov.

Disk 5 mm. across; arms 5, about 30 mm. long, tapering to very slender tips. Disk with slight radial notches, the interradial lobes not very conspicuous but extending out to the sixth arm segment, their distal margins straight or only a little concave. Disk covered with a coat of thin but not very small scales (about 10 columns between the inner ends of the pairs of radial shields), among which the 11 primary plates, well separated from each other, are rather conspicuous and there are other larger plates around the radial shields. The latter are short and rather wide (width about half length), separated for their whole length by rather coarse scales, or just in contact at their distal tips. Upper arm-plates quadrilateral with distal margin longer than proximal and all angles rounded; at base of arm the proximal margin is notably short but rapidly increases in relative length and at middle of arm is nearly equal to distal but it then decreases in length and near tip of arm tends to disappear, the plates becoming rounded triangular with the distal margin very convex; near middle of arm the plates are considerably wider than long and the distal margin is lightly convex.

Interbrachial areas below covered with a coat of small scales, not markedly

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[1] ἀκρισία = *want of distinctness*, in reference to the lack of any outstanding character.

different from those on upper surface of disk. Under arm-plates, squarish with rounded angles, about as wide as long, in broad contact. Arm-spines 6 or 5, about as long as an arm-segment, flattened and blunt; lowest more pointed and less flattened than the uppermost. Tentacle-scales 2, small, flat, and of little significance.

Oral shields rounded diamond-shape, the 2 outer sides much shorter than the inner; length equals or exceeds width, except the madreporite which is larger and wider than the others. Adoral plates, irregularly quadrangular; radial end rounded and separated by the first under arm-plate from its fellow of the adjoining jaw; interradial end wider, concave, nearly or quite meeting that of its fellow along the inner margin of the oral shield. Oral papillae not peculiar, the inner one block-like of course, the outer, erect, flattened, rounded at tip, twice as long as wide or longer.

Color of dried specimens; disk pale gray; arms pale fawn color; distally here and there an upper arm-plate may be noticed of a darker shade but such plates are not conspicuous.

Holotype, M. C. Z. no. 4941, from Broome, W. A., 5–7 fms. June, 1932.

There is a single paratype, also from Broome, which differs in no important detail from the more perfectly preserved holotype. There is so little that is distinctive about the species that it has been hard to consider it an undescribed form. It has points of resemblance with *incana* Lyman from Cape Colony, *perita* Koehler from Solor Strait, southern East Indies, and *amokurae* Mortensen from New Zealand but the outer oral papilla, the arm-spines and the disk covering combine to separate it distinctly from any one of these species.

AMPHIURA BIDENTATA[1] sp. nov.

Disk 3.5 mm. in diameter; arms 5, about 10 mm. long. Disk covered with a close coat of rather coarse but small scales, among which the primary plates are not distinguishable. Radial shields relatively large, narrow, about three times as long as wide, well separated by several coarse scales, except at the slightly incurved distal tips. Upper arm-plates broadly pentagonal or triangular; width, 2–3 times length; distal margin slightly convex; lateral margins very short or wanting; proximal margins oblique forming an angle usually in contact with, and sometimes (near base of arm) truncated by the convex margin of the preceding plate.

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[1] *bidentata* = having two teeth, in reference to the pair of oral papillae on each side of the distal end of each mouth-slit.

Interbrachial areas below covered with minute scales, more delicate than those of disk. Under arm-plates wider than long, rounded pentagonal, hardly in contact, except on basal part of arm; in holotype, the first one is relatively large, pentagonal, with an inner angle; the second is largest of the under arm-plates and in contact with both preceding and following; distal margin of most of the plates concave or slightly notched. In a specimen from Port Curtis, the first plate is smaller and triangular with a distal angle, while in a small specimen from Lagrange Bay, the first plate is almost concealed by the adoral plates which meet broadly radially. Side arm-plates large, meeting above and below, more or less evidently, except at base of arm. Arm-spines 3, subequal, pointed, about as long as an arm-segment; upper one more slender than the lower 2. Tentacles scales 2, relatively large and conspicuous.

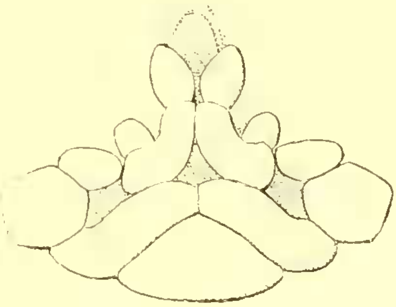

Fig. 13. Amphiura bidentata. A mouth angle. x 20.

Oral shields of moderate size, triangular with distal side convex about as wide as long; in other specimens, the shape is more rhomboidal with rounded angles, wider than long, and in one specimen, the angles are so rounded the plates are nearly ellipitical, much wider than long. Adoral plates relatively very large, meeting broadly within, but usually separated in the radial line by the large first under arm-plate; as already stated, in the specimen from Lagrange Bay they are broadly in contact radially. Oral papillae in the usual block-like form at tip of jaw, but distally there are two of nearly equal size on each side of the mouth slit. The gap between the proximal papilla and this distal pair is large and conspicuous as in typical Amphiura. The distal pair are situated on the oral plate which is relatively large, though they appear in some cases to be attached to the adoral plate and the inner one sometimes seems attached to the first under arm-plate; the two pairs make a more or less continuous semicircle around the distal end of the oral slits. Papilla protecting first oral pore rather conspicuous as a small rough knob, less noticeable in the holotype than in some other specimens.

Color of disk pale gray or nearly white with radial shields gray, their distal tips white; arms yellowish white.

Holotype, M. C. Z., no. 4947, dredged at Broome, 5–7 fms., June, 1932.

Besides the holotype, which is the largest individual seen, there are 3 paratypes taken at Broome in 1929, 5 taken in 1932, 1 at Lagrange Bay in 1929, and 2 from Port Curtis, Queensland, collected by Mr. Melbourne Ward and loaned by the Australian Museum. These Queensland specimens are undoubtedly identical with those from Broome, for while one has the oral shields less angular and more broadly elliptical than in the Western Australian material, in the other the shields are rounded triangular as in the type.

This little amphiuran will not be confused with any other Australian species as the characteristic mouth parts will distinguish it at once. There are several Amphiuras however, from other regions, with similar mouth parts, 3 arm-spines and 2 tentacle-scales, which might be separated with it as a genus distinct from Amphiura. Such species however, as *diomedeae* Lütken and Mortensen [=*koreae* Duncan, according to Matsumoto (1917, p. 198)] in which the oral papillae undergo great changes during growth and senescence, besides having a wide range of individual diversity, make one hesitate to set them apart.

Amphiura brachyactis[1] sp. nov.

Disk 5 mm. across; arms 5, scarcely 20 mm. long, narrow, tapering rapidly on distal half, to a slender tip. Disk covered with a thin coat of very small and delicate scales. Radial shields long, narrow and slightly curved, nearly or quite in contact at distal ends, well separated inwardly by numerous small scales; the length of each shield is 3–4 times its width. Upper arm-plates nearly circular or somewhat elliptical, the width greater than the length but not conspicuously so. Arm-spines 5 (6 on most proximal joints, 4 distally) short, scarcely exceeding an arm-segment, flat and bluntly pointed. Lower surface of both disk and arms so much as in *microsoma* that it would be superfluous to repeat the details here.

Color of dry adults: disk grayish, with margin more or less, yellow-brown; arms lighter colored, whitish or pale yellowish-brown.

Holotype, M. C. Z. no. 4933, from Broome, W. A., June, 1932; dredged in shallow water.

There is a paratype of about the same size and similar in all details, from the same locality. A young Amphiura which was at first thought to be *microsoma* is more probably this species, as indicated by disk-covering, radial shields and upper arm-plates.

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[1] *βραχύς* =*short*+*ἀκτίς* =*ray*, in reference to the short arms.

The close relationship of *brachyactis* to *microsoma* is so evident one hesitates to separate them, and yet the differences in length of arms, in shape of upper arm-plates and in character of the radial shields are so great and apparently constant they cannot be ignored. It is interesting to note that apparently both species occur on the northwestern coast.

AMPHIURA CATEPHES[1] sp. nov.

Disk 8–9 mm. in diameter, not perfectly circular, depressed and notched in the radii, somewhat swollen and expanded in the interradii, but the interradial margin is straight or a little concave or notched. Arms all broken but, judging from the fragments at hand, not more than 35–40 mm. long. Covering of disk made up of coarse flat scales, with the six primary plates distinguishable but not conspicuous; the radial plates circular, largest, a full half millimeter in diameter, but many other plates, particularly in the interradii between the proximal ends of the radial shields are nearly as large though rarely circular; near the disk margin the scales are smaller; there are 7–9 series in the interradii between proximal halves of the pairs of radial shields. The latter are rather more than twice as long as broad but less than 2 mm. long; the inner side is straight, the outer markedly convex; they are nearly or quite in contact distally but diverge slightly and are separated by a linear series of 2–4 scales, the most proximal the largest. Upper arm-plates, quadrilateral but the distinctly convex distal margin is longer than the straight proximal side, by which the plates are fully in contact.

Interbrachial areas below completely covered by a well developed coat of very small scales; the contrast between this covering and that of the upper side of the disk is very marked. Under arm-plates wider than long; all are more or less quadrilateral but the first one is much wider distally than proximally and is nearly as long as wide; the next 2 or 3 plates are much wider than long and the distal margin is distinctly notched; on subsequent plates the margin is slightly concave or straight; all four corners tend to be rounded. Side arm plates not conspicuously projecting, with 6, rarely 7, or further out 5, rather slender, pointed, subequal opaque arm-spines, about as long as an arm-segment. Tentacle-pores rather large but the single tentacle scale is small, scarcely one-fourth as long as the under arm-plate.

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[1] κατηφής = *dejected*, in reference to the close relationship to *A. dejecta* Koehler.

Oral shields notably longer than wide, except the madreporite which in the holotype is wider than long and relatively very large; in the paratype it is not so big and the width does not equal the length. The typical shield is elliptical or elongated octagonal with all the angles rounded; in some, the distal end is almost pointed and the adjoining sides are concave, but the degree of concavity and the breadth of the distal end show much diversity. Adoral plates completely separated within by the proximal end of the oral shield, but in the radial line they are very nearly in contact; in the paratype they do not approach each other so closely; they are more or less quadrilateral with the inner end (adjoining the oral shield) wider than the outer, and all angles very fully rounded. Oral papillae not notably peculiar the inner ones block-like as always in Amphiura, the outer rather small, flat, erect and pointed. Color of disk gray, of arms brownish-white, not in any marked contrast; the color in life was not noted and hence was probably inconspicuous as in the dry specimens.

Holotype, M. C. Z. no. 4921, from off Middle Head, Port Jackson, in several fms., November 21, 1929.

A paratype, somewhat smaller and with the arms even more deficient was dredged at the same time and place. The only differences between it and the holotype are in the adoral plates and oral shields, as already mentioned. The relationship of this Amphiura to *constricta* is obvious but these specimens cannot be considered fully grown adults of that species; the differences in the radial shields, oral papillae, arm-spines, under arm-plates and tentacle-scales cannot be reconciled with any such view. The relationship to Koehler's species *dejecta* from Sibuko Bay, Borneo, in 305 fms. is equally notable but there are too great differences in disk-scaling, in under arm-plates, in arm-spines and in tentacle-scales to permit referring the Port Jackson specimens to that species.

AMPHIURA DIACRITICA[1] sp. nov.

Disk 6–7 mm. across; arms 5, all broken, but from the pieces present it is evident they were long, probably at least 60 mm. Disk covered for the most part with a thin, naked skin, but around the radial shields are numerous well-developed, but minute, scales; these scaled areas are sharply defined and measure about 2.5 mm. long by nearly 2 mm. wide; radial shields themselves are only about 1.5 mm. long and scarcely half that in width; they are truncate distally where they are in contact, but the inner end, where they are rather widely separated is pointed. Upper arm-plates at first oval about as long as broad and not broadly in contact but rapidly becoming wider than long and fully in contact; the corners are so broadly rounded that many of the plates are almost elliptical.

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[1] *διακριτικός* = *distinguishable*, in reference to the well-marked specific characters.

Interbrachial areas below covered with a thin coat of minute, delicate scales, except to some extent along the outer margin where the naked skin of the upper surface of disk passes over onto the oral side. Under arm-plates quadrilateral, longer than wide or nearly so, with slightly rounded angles. Arm-spines numerous and crowded, usually 8 in each series; lowest longest, exceeding a segment; uppermost 2 or 3 wider, flatter, with blunt tips, about equal to segment; third and fourth, or fourth and fifth, with a sharp, minute bent tip, or posteriorly directed tooth. Tentacle-scales 2, small but well developed.

Oral shields, of moderate size, longer than wide, with a blunt inner end and a truncate, but short and rounded distal margin; madreporite very large, nearly circular. Adoral plates small, rounded triangular, not meeting either within or radially. Oral papillae conspicuous and remarkably alike in form; the distal ones are so thick and wide (though width is less than length) they resemble to an unusual degree the inner ones, which are widely separated from each other on the truncate end of the jaw and are less square and block-like than is usually the case.

Color of naked skin very dark brown; of radial shields and adjoining scales, arms and arm-spines, nearly white or very light cream-color.

Holotype, Australian Museum no. J 5077, from Queensland, Whitsunday Passage, Black Island.

This Amphiura is quite unlike any species as yet known from Australia. It belongs in the same group as *arcystata* H.L.C. of Japan but is easily distinguished from that species by the outer oral papillae, the form of the arm-spines, and the much smaller radial shields. The Japanese species shows such diversity in the amount of calcareous material in the disk covering, one cannot feel sure that the unique holotype of *diacritica* is typical of the Australian species, when fully adult. There is a remarkable resemblance between the present species and Koehler's figures (1926, Pl. II, figs. 3–7) of Ljungman's species *verticillata* from the Galapagos Islands, also described from a single specimen. But neither Ljungman nor Koehler describe the disk as naked though Koehler's figures suggest the possibility that it might have been.

AMPHIURA DOLIA[1] sp. nov.

Disk 11–12 mm. in diameter; arms 5, 65–70 mm. long, tapering rather abruptly distally to a long slender tip. Disk somewhat swollen, strongly notched radially, the interradial lobes extending out to the tenth arm-segment; the margin of the lobes is either straight, or slightly concave; disk covered with a dense coat of small but rather thick scales, among which a few near center of disk are somewhat larger but no definite primary plates can be distinguishd. (In one of the paratypes, the primary plates are quite evident). Interradial areas have about 10 series of plates, between the adjoining pairs of radial shields, while along the margin of each lobe there are at least 30 series. Radial shields small, strongly divergent but nearly or quite in contact distally; each is 2 mm. long and 1 mm. wide (at middle); inner margin straight, outer strongly convex. Upper arm-plates quadrilateral with all angles somewhat rounded; distal side longest (at middle of arm, more than twice as long as lateral margins) and very slightly convex; proximal side distinctly shorter and lightly concave; near the base of the arm (and in the young paratype), the distal margin is shorter and much more convex.

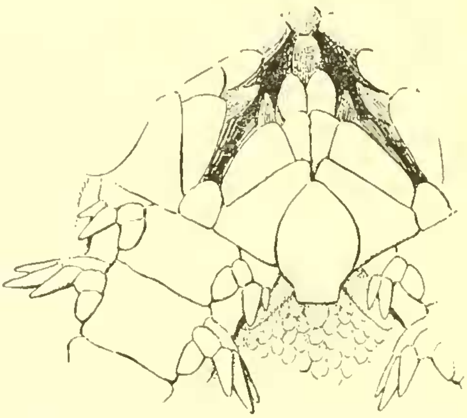

Fig. 14. Amphiura dolia. A mouth angle and basal portion of one arm. x 20.

Interbrachial areas below densely covered with small, thickish scales, like those near the margin of the interradial lobes when seen from above. Arm-spines 7, rarely 8 basally, becoming 6, at the tenth to twelfth segment; excepting only the uppermost 2 or 3, they are subequal (or the next to the lowest may be longest) and scarcely exceed an arm-segment; they are terete, little or not at all flattened, pointed but not acute. Under arm-plates quadrilateral, broadly in contact, wider than long and for the most part wider proximally than distally; distal angles rounded and distal margin very slightly concave; proximal margin tends to be convex or even bluntly pointed, but in the normal position of the straight arm, it is overlapped by the distal margin of the preceding plate sufficiently to conceal this insignificant feature. Tentacle scales 2, large, flat, roughly semicircular; outer one, situated on side arm-plate, a trifle smaller than the one attached to the under arm-plate; together they fill snugly the space from base of lowest arm-spine to distal corner of under arm-plate.

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[1] δολιός = *deceptive*, in reference to resemblance of the outer oral papillae to those of some Amphiodias.

Oral shields spear-head shape, distinctly contracted distally, longer than wide; madreporite larger, more broadly oval, swollen. Adoral plates somewhat triangular, with angles rounded and side adjoining oral shield distinctly concave; the plates meet within but radially are separated by a small but very evident first under arm-plate. Oral papillae very striking; inner pair block-like as usual but outer pair low, very broad with rounded free margin; at first sight the mouth parts look like those of some Amphiodias but a closer examination shows that there are only 2 papillae on each half of the jaw; the small intermediate papilla of Amphiodia being entirely wanting but of course, the pointed scale of the first (oral) tentacle is present and is conspicuous enough to be misleading.

Color of dry specimen nearly uniform light gray, though the arms are somewhat lighter than the disk. The young paratype, which was never in alcohol, has the disk pale gray, the arms more nearly white, very much the coloration shown in life.

Holotype, Australian Museum no. J 6037, from Port Jackson, with no further data.

There are two paratypes in the same lot with the specimen described above, not quite so large, and one badly damaged. They agree in all essentials with the type but in one the maximum number of arm-spines is 7 and in the other only 6.

A young individual of *dolia* was dredged off Middle Head, Port Jackson, in 4–6 fms., November 21, 1929. It is only 3 mm. across the disk and the arms are little more than 15 mm. long. The characteristic mouth parts and tentacle scales are exactly as in the adults but the radial shields are relatively larger and narrower, and the maximum number of arm-spines is 4, or perhaps 5 on some basal arm-segments.

This species is so well marked by its conspicuous and unusual oral papillae that it will not easily be confused with any other member of the genus.

AMPHIURA LEUCASPIS[1] sp. nov.

Disk scarcely 3 mm. across, arms all broken but judging from a paratype, they were hardly 10 mm. long. Disk covered with coarse scales among which the 11 primary plates are obvious, though the interradial plates are smaller than the radial. Radial shields relatively large but not so long as one-half the radius of disk; width more than one-half length; inner end pointed, outer end blunt; inner margin straight, outer strongly convex; inner ends well separated by 2 or 3 scales, outer ends broadly in contact. Upper arm-plates four-sided, broadly in contact, but inner margin, which is straight, is much shorter than the distal, which is strongly convex; corners not rounded.

Interbrachial areas below fully covered with rather coarse scales, smaller than most of those on disk. Under arm-plates squarish or a trifle longer than broad, with rounded corners, broadly in contact. Arm-spines 6 (soon 5, then 4) erect, bristling, more or less cylindrical but thicker at base than at the bluntly pointed tip; upper ones shortest, lowest two longest and subequal, rather longer than a segment. Tentacle-scale single, huge; width more than half length, which nearly equals under arm-plate; tip rounded; distally the scales are smaller both actually and relatively than at base of arm. Oral shields triangular, with distal margin strongly convex, or spear-head shaped with distal squarish projection very short; all angles rounded; length about equal to width; madreporite not conspicuously bigger. Adoral plates triangular, rather large, but scarcely meeting either without (radially) or within; proximal side lightly concave. Oral papillae notable; inner ones flatter, not quite so blocklike as usual; distal ones very large, semicircular or more nearly circular, the width and height nearly equal.

Color very characteristic; disk pale gray, many scales darker at margin than at center; radial shields dark gray at inner end and along outer margin but elsewhere pure white in strong contrast. Upper arm-plates mostly light gray but frequently white in striking contrast; distally white plates are more frequent; sometimes 2 consecutive plates are white; in life the arms seem to be white banded with gray; arm-spines very pale gray. Lower surface of both disk and arms, white.

Holotype, M. C. Z. no. 4929, from Lagrange Bay, Western Australia, 5–7 fms., September, 1929.

No other specimen of this well-marked little amphiurid was taken in 1929 but in 1932, 2 specimens were dredged in different places in the Broome region. They are like the holotype in all essentials. The coloration, the huge tentacle-scale and the big outer mouth papilla distinguish this Amphiura from any with which it might be confused. Its small size naturally leads to its being readily overlooked and the specimens secured were found only by painstaking examination of sand and mud brought up in the dredge. Whether these little individuals are adult is of course uncertain.

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[1] λεύκασπις = *with white shield*, in reference to the conspicuous white area on each radial shield.

AMPHIURA MAGNISQUAMA[1] sp. nov.

Disk 3.5 mm. across; arms 5, about 14 mm. long. Disk covered by unusually large scales among which the rosette formed of 6 primary plates is conspicuous, nearly 1.5 mm. across; central plate itself is about half a millimeter in diameter; in each interradius between the pairs of radial shields are 6 or 7 series of overlapping scales. Radial shields short and moderately wide, well separated proximally but nearly in contact distally. Upper arm-plates broadly in contact, 4-sided, with inner side straight, and narrower than outer which is a little convex.

Under arm-plates rather large, as long as wide or longer, with lateral margins concave and distal margin convex, the distal corners rounded. Arm-spines 5 (or 6 on basal joints), sub-equal or lowest longest; opaque, flattened, bluntly pointed, about equal to segment. Tentacle-scale single, rather small, situated on the side arm-plate close to the middle of the concave lateral margin of the under-arm-plate; it seems to be easily detachable as it is missing in these dry specimens, from many pores.

Oral shield triangular about as wide as long, all angles rounded but innermost least so. Adoral plates relatively very large, triangular, hardly meeting within and separated in the radial line by a very small first under arm-plate. Oral papillae, 2 on each side of jaw; terminal one block-like as usual, distal one 3 times as big, flat, thick, rounded. Color pale gray, more or less white orally.

Holotype, Australian Museum no. J 3504, from 2.5 to 4 miles off Botany, New South Wales, 33–56 fms. McNeill and Livingstone, on trawler "Goonambie," leg.

There are 3 paratypes from the same station and 3 from off Botany Bay, 50–52 fms., "Thetis" collection. All the specimens are more or less broken, but all show the distinctive species characters well. These are, the coarse disk-scaling with conspicuous rosette of primary plates (irregular in one small specimen), the huge, flat, distal oral papillae, the single small tentacle scale and the 5 subequal, opaque arm-spines.

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[1] *magnus* = big + *squamus* = scale, in reference to the unusually large disk scales.

AMPHIURA MICRA[1] sp. nov.

Disk 1.8 mm. across; arms 5, 6 mm. long. Disk flat, rounded pentagonal, covered by rather more than 100 smooth, thickish scales, of which 6 primary plates are much the largest while 75 small irregular ones cover the interradial areas and separate the inner ends of the radial shields; 25–30 considerably larger plates form 2 ill-defined circles around the primaries. Radial shields short and wide; length not quite half disk-radius; width about one-half length; in contact at distal tip but separated at inner ends. Upper arm-plates, rounded triangular or the proximal angle may be truncated to form a short margin; the plates are slightly swollen and more or less in contact.

Interbrachial areas below well plated with rather coarse scales. Genital slits short but evident. Under arm-plates longer than broad, fully in contact. Arm-spines 4 on proximal part of arm, 3 distally where they are more slender and acute, subequal or uppermost a trifle the longest; the proximal ones moderately thick at base, terete and pointed, about as long as an arm segment. Tentacle-scale single, small, not peculiar. Oral shields relatively large, triangular with all angles rounded, about as wide as long. Adoral plates small lying wholly at the sides of the oral shields. Oral papillae not peculiar, the inner block-like and relatively large, the outer peg-like, but flattened, its width about one-half the length.

Color of dry specimen, disk pale gray, arms dirty white; lower surface more or less white.

Holotype, M. C. Z. no. 4935, from Broome, September, 1929.

This little brittle-star was found with other small specimens, after the return to Cambridge, and there are no data with it. Owing to its small size its peculiarities were not noted until the collection was being critically studied. While it is probably immature it is not the young of any of the other Amphiuras now known from Broome. The character of the disk, the arm-plates and spines, and the form of the oral shields make a combination of recognition marks that serve to distinguish it.

AMPHIURA MULTIREMULA[2] sp. nov.

Disk 7 mm. across; arms 5, 40 mm. or more in length. Covering of disk consists of a coat of very minute and very numerous scales, while here and there, near center of disk, a larger one is distinguishable; in the paratypes, these larger plates seem to be the primary plates but they are well separated from each other. Disk somewhat notched radially so that 5 interradial lobes, with slightly concave margins are evident but not swollen. Radial shields small about 1 mm. long or possibly a little more, .30–.40 mm. wide, pointed and well-separated proximally but blunt and more or less in contact distally. Upper arm-plates at first, rounded pentagonal or hexagonal, approaching circular, about as long as wide, but rapidly increasing in width until they are tetragonal, much wider than long, with rounded outer corners, a lightly concave distal margin, a straight or somewhat convex proximal edge and lateral sides distinctly convex.

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[1] μικρός = *small*, in obvious reference to the minute size.

[2] *multiremula* = having many little oars, in reference to the regular vertical series of numerous arm-spines, the upper ones flattened like paddles.

Interbrachial spaces below completely covered with a coat of extremely minute scales. Under arm-plates squarish, with rounded corners and fairly straight margins, broadly in contact, usually longer than wide but near middle of arm some plates are a bit wider than long. Arm-spines at base of arm in vertical series of 8 (rarely 9); further out, the number decreases, as usual, and there are 7, 6 and distally 5; the 2 lowest spines are longest, exceeding an arm-segment, flattened, with moderately wide truncate tips; the three uppermost are similar but shorter with tips rounded rather than truncate, while the three intermediate spines are shortest and least flattened and most pointed; the difference between these groups is not sharply defined, but it is evident enough when the entire series is viewed as a unit from either end of the arm; the resemblance of the upper spines to short paddles is rather striking in the holotype but in the somewhat smaller paratypes only the uppermost spine or two has that appearance. Tentacle-scales 2, rather large, flat; the one on side arm plate, longer than wide, rounded at tip; the one adjoining under arm-plate hardly as long as wide, with a broadly curved margin.

Oral shields, broadly oval or rounded pentagonal, with a blunt point proximally and a short side distally; width usually equals or exceeds length; in the holotype, the oral plates close to the tip of the shield are notably depressed and there is a dark brown spot, the combination giving the impression that the proximal point of the oral shield is suddenly bent downwards; this is not noticeable in the paratypes though the depression of the oral plates is evident and in one specimen there is a trace of pigment; it may be that the odd appearance in the holotype will be found in all fully mature, or perhaps only in senescent, specimens. Adoral plates more or less triangular with concave sides and broadly rounded angles; they are separated radially by the first under arm-plate; in the holotype they are widely separated within by the oral shield but in the paratypes they more nearly meet and in the younger specimen, they meet fully in at least one interradius. Oral papillae, block like as usual at tip of jaw but erect and spine-like at distal angle; this distal papilla is flattened, and rounded or roundly pointed at tip, the length ranging from 2 to 4 times the width. Tentacle scale of first oral tentacle exceptionally conspicuous, elongated, blunt and thick.

Color of dried holotype light brownish-gray, with little difference between disk and arms; on middle third of each arm a plate here and there or sometimes 2 together are more or less dull purple; in life the contrast was probably rather marked; on the lower surface, the brown spots on the oral plates have already been mentioned; in addition there are faint brownish markings on the oral shields and adoral plates, the lateral markings of the under arm-plates are faintly dusky and the flattened lower arm-spines show a longitudinal brownish stripe. The paratypes are much lighter colored; the disk is pale gray (in one, with a yellowish margin) and the arms nearly white; here and there an upper arm-plate is darker than its fellows; on the oral surface, in one specimen, the brownish markings are very faint indeed, except for the evident stripe on the lower arm-spines, while in the youngest individual, there is no indication of pigment at all.

Holotype, M. C. Z. no. 4938, from Long Reef, Colloroy, New South Wales, November 28, 1929.

There are two paratypes with disks nearly or quite 6 mm. in diameter and arms all broken. One was taken on Long Reef, the same morning that the holotype was found. The other was dredged off Middle Head, Port Jackson, in 4–6 fms., November 21, 1929. It seems strange that so remarkable a brittle-star should have lived so long undiscovered near Sydney but it does not seem to have been described hitherto. It will be easily recognized by the noticeable series of arm-spines, in combination with 2 tentacle scales and the very fine disk scaling.

Amphiura nannodes[1] sp. nov.

Disk about 2.5 mm. across; arms 5, about 10 mm. long. Disk covered with a coat of very thin but not particularly small scales with no primary plates distinguishable; in the smallest paratype with disk less than 2 mm. across, 6 primary plates can be distinguished. Radial shields long, straight and narrow, separated or barely in contact distally and diverging slightly within; length 3 times width or even more (less in the young paratype). Upper arm-plates at base of arm oval about as long as wide but width increases rapidly and soon exceeds length very evidently; the plates are then oblong with rounded corners and distal margin longer than proximal.

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[1] *ναννώδης* = *dwarfish*, in reference to the small size.

Interbrachial spaces below covered uniformly with a coat of small scales. Under arm-plates longer than wide with slightly rounded corners, broadly in contact. Arm-spines 6 on basal arm-segments, then 5, subequal or lowest the longest, about as long as an arm-segment, bluntly pointed. Tentacle-scales 2, small and delicate; the one on under arm-plate is often narrow and difficult to see; apparently one or both are easily lost in dried specimens. Oral shields very broad, usually wider than long, oval or elliptical, with little or no proximal angle. Adoral plates large, triangular with all angles rounded and sides concave, not meeting either without or within. Oral papillae as usual in Amphiura, block-like at tip of jaw and erect, flattened spine-like at distal angle; sometimes this distal papilla is bluntly pointed and little flattened but usually it is rounded at tip and half as wide as long.

Color of dried specimens, disk pale gray, arms more or less nearly white.

Holotype, M. C. Z. no. 4944, from under stone in cove at Bathurst Point, Rottnest Island, W. A., October 19, 1929.

Besides the holotype, half a dozen paratypes are at hand also from Rottnest Island, 3 of which were taken by Mr. G. Bourne in 1931.

This little amphiurid is nearly related to the species from Mozambique, called *candida* by Ljungman, of which the type was 5 mm. across the disk. Koehler (1904) considers Ljungman's type worthless and redescribes the species from a specimen in the Vienna Museum, identified by Marktanner-Turneretscher, which was 8 mm. in diameter and came from Japan. This identification of the Japanese specimen with Ljungman's Mozambique species seems to me questionable but until more material from East Africa is available, the matter must stand as it is.

The present small Amphiurid is distinguishable from *candida* by the coarser disk-scaling and absence of primary plates in adults; by the differences in the oral shields and outer mouth papillae; and insignificant differences in arm-plates and spines. It will not be surprising when small specimens of *candida* are taken at Mozambique to find that the Rottnest Island amphiurids are indistinguishable, but until such material is available it is better to keep the Australian species separate.

Amphiura phrixa[1] sp. nov.

Disk up to 7.5 mm. in diameter, the 5 arms 5–7 times as much. Disk flat, covered with coarse scales and broad radial shields; the primary plates may be evident but often are not. Upper arm-plates in contact, broader than long at base of arm, further out about twice as wide as long; distal margin strongly convex. Interbrachial areas below covered with a very fine scaling. Under arm-plates wider than long, the distal margin straight or slightly concave, the corners rounded. Arm spines in bristling vertical series; at base of arm, there are 8–10 spines in a series, the uppermost smallest, the lowest longest; upper ones shorter than an arm-segment, lower ones longer; all the spines are of moderate thickness at base more or less tapering and pointed, more or less flattened, and opaque. After ten or a dozen joints (in adults) the number of spines in a series decreases to 7, 6, 5 and distally to 4. In young specimens (with disk 2–3 mm. across), the number of spines is of course less, 6 or 7 on the basal joints and 3 distally, but the bristling character of the spines is noticeable in all specimens, young or old. Tentacle-scale single, oval, moderately large on basal pores but becoming very small distally. Oral shields spear-head shaped; in young and half-grown specimens longer than wide, the inner end sharp-pointed, the constriction of the distal end rather marked and the lateral angles rounded; in adults, the width equals or exceeds the length (particularly in the more or less enlarged madreporite) and the inner end is blunter, the distal constriction less conspicuous. Adoral plates small, not meeting within, but meeting more or less nearly in radial line. Oral papillae as usual, a block-like pair at the inner end of the jaw, and erect, flattened ones at the distal angle on each side; these distal papillae show no little diversity in size and in width but are not notable in any way. Color of dried material, disk more or less gray, arms more or less white or pale yellow; in the best specimens, the disk is variegated with light and dark gray and many upper arm plates are gray; these gray plates often occur in irregular groups so that the arms appear faintly, or sometimes rather evidently, banded. In my field notes, the color in life is given simply as "gray and white."

Holotype, M. C. Z. no. 4923, from mud south of jetty, Broome, W. A. August, 1929.

This is one of the common brittle-stars of Broome, (56 specimens are at hand) living in the sandy mud of Roebuck Bay, in shallow water. It was frequently taken when dredging in June, 1932, in 5–8 fms. but the finest specimens were secured when digging in the vicinity of the jetty during low water, sifting the mud in a sieve. It was not met with anywhere except in or near Roebuck Bay.

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[1] φριξός = *standing on end, bristling,* in reference to the characteristic arm-spines.

No detailed description is needed, for *phrixa* is so obviously closely allied to *constricta, dejecta* and *catephes*, that such a description would be a waste of words. It is only necessary to emphasize the distinctive characters, a flat rather pentagonal disk with broad radial shields, spear-head shaped oral shields, which in adults tend to be as broad as long, and the very numerous bristling arm-spines. Apparently *phrixa* is one of the amphiurids which sheds its disk to release the eggs and sperm when breeding, for all of the adult specimens indicate more or less clearly that the present disk has been regenerated and is not yet quite full-grown.

AMPHIURA PTENA[1] sp. nov.

Disk 5.5 mm. in diameter; arms 5, length indeterminable since all are broken near the disk and no fragments are with the specimens. Disk covered with a coat of very small but rather thick scales; those near the radial shields are somewhat larger than elsewhere while those at center of disk are the smallest. Radial shields notably small, about twice as long as wide, separated except at distal ends by one or more large scales. Upper arm-plates on first 2 or 3 segments nearly circular, but rapidly becoming elliptical and nearly twice as wide as long, broadly in contact.

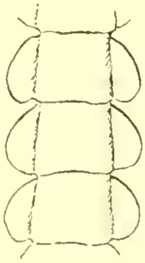

Fig. 15. Amphiura ptena. Three under arm-plates with their accompanying tentacle-scales; the lowest plate is nearest the mouth. x 20.

Interbrachial areas below well covered with a coat of minute but not delicate scales. Under arm-plates quadrilateral, slightly longer than wide. Arm-spines 6–8 in bristling vertical series, the upper ones more or less flattened the lower more cylindrical; all are blunt, subequal and rather longer than an arm-segment. Tentacle scales single (fig. 15), extraordinary in form and size; it is as long as the under arm-plate and attached to it along the entire lateral margin like a wing; near base of arm it is nearly half as wide as its length but it narrows more and more until it disappears distally. Oral shields oval, longer than wide, the madreporite largest; in the smaller paratypes the shields are rounded triangular, about as wide as long, and the madreporite is not conspicuously largest. Adoral plates somewhat elongated triangular, scarcely or not, meeting within, well separated radially by the first under arm-plate. Oral papillae notably small; inner pair unusually small and inconspicuous; outer ones, low, wide and rounded at tip. Color of dried specimens, disk light grayish, arms light yellowish-brown; nothing whatever distinctive.

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[1] πτηνός = *winged*, in reference to the remarkable tentacle scales.

Holotype, M. C. Z. no. 4931, from the beach at Bunkers Bay, Western Australia. January, 1930. E. W. Bennett leg. et don.

Besides the holotype, there are 2 smaller specimens, in very poor condition, taken with the larger specimen. The remarkable tentacle-scale is a very striking recognition mark for this hitherto undescribed amphiurid. Apparently it is a mud-loving form as there are traces of dried mud on the largest individual. Professor Bennett's notes speak of "intertidal pools" with "a little muddy sand."

AMPHIURA STICTACANTHA[1] sp. nov.

Disk 5 mm. in diameter or a little more, bulging pentagonal, flat or concave in dry specimens, with a deep notch in each radius and each interradial margin concave or notched. Arms 5, about 35 mm. long. Disk densely covered with a coat of very small scales, largest around the inner ends of the radial shields, smallest at center of disk where there is no indication of primary plates. Radial shields long and very narrow, very near together and almost parallel, but more or less in contact distally and clearly separated within; length is 4 or 5 times width. Upper arm plates oval at base of arm and about as long as wide, the distal end wider than proximal; width increases steadily until at middle of arm it is much more than length and the proximal margin is more nearly the same as the distal; except at very base of arm, the plates are broadly in contact with each other.

Interbrachial areas below closely covered with fine scales. Arm-spines numerous and crowded; at very base of arm there may be 9 or 10 but 8 is the regular number until towards the middle of the arm it drops to 7; lowest spine longest

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[1] *στικτós* =*spotted*+*ἄκανθα* =*spine,* in reference to the streaks and spots of brown on the arm-spines.

and most slender, equal to about 1.5 segments; the next one is shorter blunter and more flattened; the next 2 or 3 are noticeably smaller and the upper 3 or more are flat, wide, with rounded tips, subequal and about as long as a segment; on the basal part of the arm, the 2 series on opposite sides of the same segment approach each other quite closely on the dorsal surface. Under-arm plates quadrilateral, broadly in contact, with slightly rounded corners rather longer than broad. Tentacle-scales 2, an oval one on side arm-plate and a more elongated one on under arm-plate.

Oral shields oval, as wide as long, the distal side somewhat projecting but not markedly so; madreporite much the largest. Adoral plates short triangular with broad rounded corners and slightly concave sides; they do not meet either within or radially, but they are near enough together to suggest that the separation may be due largely to the drying of the specimen. Oral papillae as usual, block-like at point of jaw, and erect, flat, with rounded tip, at distal angle.

Color of dried specimen, disk very pale gray becoming nearly white on interradial margins; on some radial shields a pale brown area distal to middle is visible. Arms whitish with here and there, especially on distal half, an upper arm-plate or two, yellowish or pale brown; arm-spines streaked and speckled with brown, irregularly but very evidently. In young individuals, the arm-spines are less opaque and the brown markings are much less evident.

Holotype, M. C. Z. no. 4951, dredged at Broome, W. A., 5–7 fms. June, 1932.

Besides the holotype, there are 5 paratypes also from Broome, taken in 1932. They agree well in all essentials with the specimen described but have more brown markings on both disk and arms; in one specimen the marks, particularly on the radial shields are blackish. Two of the specimens are obviously young, the smaller having the disk less than 3 mm. across but the arms are nearly as long, relatively as in the adults. The arm-spines are more glassy, less flattened and much more acute than in the adults, but in the latter those near the tip of the arm are much more slender and pointed than they are basally. In the smallest specimen the upper arm-plates are all longer than wide, quite oval and not so broadly in contact; on many, a pair of longitudinal brown stripes is evident. Besides the specimens from Broome, a small individual from Rottnest Island with disk about 3 mm. across and arms nearly 18 mm. long, seems to be the young of this species. It is somewhat darker colored but shows the dark spots on the radial shields, and the upper arm-plates are oval and double striped as in the youngest specimen from Broome. From Bunkers Bay, Professor Bennett has sent two Amphiuras, in rather poor condition, which are apparently identical with the specimens from Broome. The disks are 3.5–5 mm. in diameter, but the arms are all broken only a few basal joints remaining. The disk scaling is a little coarser and the radial shields a little shorter and wider than in typical *stictacantha*. These specimens are more bleached than those from Broome and the spots on the radial shields are not evident, but enough of the brown markings on the arm-spines remain to indicate the probable identity of the specimens.

There is no doubt that this species is closely related to *candida* but the absence of primary plates on the disk, the shape of the oral shields, and particularly the number and appearance of the arm-spines indicate that these Western Australian Amphiuras cannot be referred to Ljungman's species (See above, p. 231, under *nannodes* for further reference to *candida*). That *nannodes* is not the young of *stictacantha* is proven by the smallest paratype of the Broome species which while no larger than the type of *nannodes* has much longer arms and very different arm-spines, and is clearly not identical therewith.

OPHIOCENTRUS DILATATUS

Ophiocnida dilatata KOEHLER, 1905. Siboga Oph. Litt., p. 30.
Ophiocentrus dilatatus KOEHLER, 1922. Bull. 100 U. S. Nat. Mus., **5**, p. 199.

This well marked species has been found at several East Indian stations, including the Aru and Kei Islands, and also in the Torres Strait region, but its secretive habits have prevented any considerable number of specimens being taken. It is interesting to record it now from Darwin, thus considerably extending its known Australian range.

On July 1, 1929, while dredging near the jetty at Darwin, in 5–7 fms. on a muddy bottom, we took a small amphiuran, while is clearly an Ophiocentrus. The disk is less than 2 mm. across while the delicate arms are fully 10 mm. long. The specimen is of course too youthful for certain identification but in view of taking an adult of *dilatatus* only a few days later near the Shell Islands, I have no doubt this is a young individual of that species.

On July 5, dredging in 3–6 fms. near the Shell Islands, yielded many fragments of coral rock overgrown with sponges, alcyonarians, etc. Crowded into a small cavity of one of these rocks was an ophiuran of considerable size which proved to be an adult *dilatatus*. The disk was 9 mm. across (8 in the dry specimen) and the arms were fully 50 mm. long; unfortunately, the animal broke off all of its arms before we reached the laboratory and the longest stump now attached to the disk is less than 30 mm. The dilatation of the arms beyond the disk margin is very marked as is the stoutness of the upper arm-spine. The color in life is recorded in my field notes as "buff with upper arm-plates dusky." The dry specimen is nearly white, but the disk is a little darker than the arms.

OPHIOCENTRUS PILOSUS

Ophiocnida pilosa LYMAN, 1879. Bull. M. C. Z., **6**, p. 32.
Ophiocentrus pilosus KOEHLER, 1922. Bull. 100 U. S. Nat. Mus., **5**, p. 199.

A small brittle-star, loaned by the Australian Museum, but unfortunately without data of any kind, proves to be a young individual of this species for which Bass Strait was one of the original localities. It was taken by the "Thetis" at several stations off the coast of New South Wales, and this specimen may well be from that material. It measures 4 mm. across the disk and the badly twisted arms are probably over 30 mm. long. The disk is pale gray, the arms nearly white.

OPHIOCENTRUS VERTICILLATUS

Ophiocnida verticillata DÖDERLEIN, 1896. Denk. Ges. Jena, **8**, p. 287.
Ophiocentrus verticillatus MATSUMOTO, 1917. Mon. Jap. Oph., p. 213.

A species of Ophiocentrus (=Amphiocnida Verrill, as Matsumoto and Koehler have agreed) is common in the sandy mud of Roebuck Bay, particularly about the jetty at Broome. There are at hand 25 specimens from the "jetty flat" taken in 1929, and 3 small specimens which were dredged in June, 1932, in 5–8 fms. further away from Broome. The smallest individual is only 1.8 mm. across the disk and has arms about 9 mm. long; the disk is pale gray, the arms white. It would be quite unidentifiable were it not for the series available for comparison. The adults measure 6–14 mm. across the disk with arms 50–100 mm. long; the arms range from 5 to 9 times the disk.

As the adults correspond almost perfectly with Döderlein's description and photographs (Pl. 15, figs. 7, 7a) the identity seems fairly certain, but the figures given by Döderlein, as drawn by an artist (Pl. 14, figs. 2a, 2b) do not correspond with the photographs and cannot be trusted. This is particularly true of the series of arm-spines (fig. 2b) which is quite unlike the series as it actually occurs. The spines are not wide, flat and rounded at tip, with the middle ones longest; examination of the photograph shows they are more or less acute, of diverse lengths, the lowest longest; in the specimens at hand from Broome those just below the middle of the series are smallest. Koehler's (1922, p. 201) view that his species *vexator* "is very close to *verticillatus*" is quite correct. In fact were it not for Döderlein's unfortunate figure of the arm-spines he would probably have identified his specimens as *verticillatus*. That I think is probably the case. Whether Matsumoto's Japanese specimens which he (1917, p. 213) refers to *verticillatus* are really Döderlein's species seems to me more dubious. There are only 7 or 8 arm-spines even in large specimens, at base of arms, and the under arm-plates are of quite a different shape. But until Japanese specimens can be compared directly with material from Amboina or Australia, the question cannot be settled.

My field notes made at Broome in 1929 read: "Reminds one of *Ophiothrix longipeda* especially in color, but arms are stiff, brittle and not so long as in *longipeda*. Rather inert, does not break up much. Common on flat, about half-tide, deeply buried in mud. Tends to violet or yellow coloration, as in *longipeda;* young ones are light violet." One had "longer arms, conspicuously banded purple and yellow." Preserved material both dry and alcoholic has lost all trace of bright colors; the specimens are for the most part light yellow-brown (museum color), lightest, almost white, near the arm tips. Some specimens are nearly white. Two are light purplish-gray, very different from the rest; one is a dry small individual, the other a large adult in alcohol. It is hard to find any reason for this rather striking difference.

OPHIOCENTRUS FRAGILIS[1] sp. nov.

Disk about 5 mm. across, pentagonal with concave interradii, very flat. Arms 5, long and slender, not tapering very much till near the tip, about 60 mm. in length. Disk covered with a coat of rather large but very thin, overlapping scales, which are more or less concealed by the numerous, slender, pointed, fragile spines, about .20–.30 mm. long, which they bear. Radial shields long (1.5 mm.), narrow (.25 mm.), straight and nearly parallel, the proximal half separated from its fellow by 1–3 very narrow, elongated scales. Upper arm-plates thin and transparent, so that the dorsal furrow in the vertebrae shows through as a dusky line; the plates are much wider than long with a highly convex distal margin, a short straight proximal side and oblique, markedly concave lateral margins; on basal part of arm, in rather broad contact but distally separated from each other by the meeting of the side arm plates; under a magnification of 90x, the surface of the plates is seen to be closely covered with minute pits.

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[1] *fragilis* = fragile, in reference to the delicate structure.

Interbrachial areas below covered like the disk, with large thin scales bearing many small, slender spines. Under arm-plates elongated hexagonal, much longer than wide, with long, concave, lateral margins, convex distal margin with rounded corners, a short straight proximal side, and oblique margins connecting this with the lateral; they are in contact more or less considerably, sometimes so much so that they are simply oblong with rounded corners. Side arm-plates large, meeting above on distal part of arm, but not below. Arm-spines, flat, pointed (but not sharply), delicate, except the next to the lowest which is stouter, especially near base and is bidentate at tip; typically there are 6 spines, the uppermost and lowest longest, much longer than an arm-segment, the middle ones about equal to segment; on basal part of arm some segments have a seventh spine present above the long sixth but it is distinctly shorter; all the spines lie flat against the arm but this may be artificial and not characteristic of the species. There is no tentacle-scale on the big arm-pores.

Oral shields oval, markedly wider than long; madreporite considerably the largest. Adoral plates small, somewhat triangular with rounded angles and concave sides, not meeting within and widely separated radially by the first under arm-plate which is unusually large. Oral papillae 2 on each side of jaw; the proximal block-like as usual but unusually thick and heavy, the distal a thick, pointed scale about half as wide at base at it is high. Tentacle-scale of first oral tentacle unusually large and conspicuous; it might easily be mistaken for an oral papilla.

Color of dry specimen, disk pale gray but its spinelets, as well as the whole lower surface, arms and arm-spines, white.

Holotype, Australian Museum no. J 6040, from 22 miles east of Port Jackson Heads, 120 fms. Trawled by Capt. K. Moller. Loaned by Australian Museum.

This very delicate and well characterized amphiurid was found among a considerable number of brittle-stars brought in by Captain Moller. The delicacy of its structure and its very light color give it an appearance very different from any of the other known species of Ophiocentrus. The narrow straight radial shields are noticeable, while the abundance of delicate spines and slender spinelets on arms and disk is striking.

Ophionephthys octacantha

H. L. Clark, 1915a. Mem. M. C. Z., **25**, p. 239.

A very large Ophionephthys was found in the sandy mud of the "jetty flat" at Broome with *Ophiocentrus verticillatus*, but only a single specimen was secured. It measures 9 mm. across the greatly shrunken dry disk and the arms are 175 mm. long, more or less (all are somewhat broken). The bare skin of the disk is dull greenish-brown, the radial shields and adjacent plates white, the arms yellow-brown, lighter distally and faintly banded near the extreme tip. In all essentials this specimen agrees well with the unique holotype of *O. octacantha* from Torres Strait. It is very much larger and there are 9 arm-spines on some basal segments, but the oral shields and papillae, the upper and under arm-plates, and the form, size and arrangement of arm-spines, agree very well with *octacantha*, so it would be foolish to attempt to describe it as a different species. The outer mouth papilla, the form of the oral shields, and the series of arm-spines with the long lower ones flattened and truncate at tip are very characteristic.

Ophionephthys decacantha[1] sp. nov.

Disk 5 mm. in diameter; arms 5, obviously very long but all are broken; the longest stump is 20 mm. Disk as usual in the genus, perfectly bare above and below, save for a narrow band of scales around, and between the distal ends of, the radial shields, which are pointed at the inner end and about 1.5 mm. long; the width of each is only about one-sixth of its length. Upper arm-plates oval or elliptical, longer than broad, relatively very small, in contact at base of arms but distally very nearly or quite separated by the series of arm-spines.

Under arm-plates longer than broad, fully in contact; basally, the distal end is narrower and more rounded than the straight or slightly concave proximal margin but this difference soon disappears and the two ends are nearly of the same width and form. Side arm-plates prominent nearly or quite meeting dorsally; each carries a series of 10 long, delicate, flattened and blunt spines, of which the uppermost four are nearly equal and slightly exceed the arm segment; the lower ones are longer, fully half again as long as a segment; their tips are blunt and spinulose; the two series of each segment are so closely approximated in the mid-dorsal line that they form a continuous series encircling the arm, which nearly or quite separates the upper arm-plates; the four uppermost spines tend to lie flat along the arm (in this specimen) concealing the arm-plates, but the others stand out at a right angle (more or less) with the long axis of the arm. Tentacle-pores large but tentacle-scale, none.

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[1] δεκακάνθα = *having ten spines*, in reference to the large number of arm-spines.

Oral shields wider proximally than distally; the inner convex margin is longer than the concave lateral margins and three times as long as the distal blunt end; madreporic plate much larger than the other shields, its lateral margins scarcely concave. Adoral plates relatively large but they do not meet either within or radially; they are scapula-shaped with the narrow end inward and the strongly concave side against the oral shield. Inner oral papillae block-like as usual; outer ones scale-like but thick, truncate and wider at tip than base, but a little longer than wide. Papilla protecting first oral tentacle, large and conspicuous.

Color of dry disk yellow-brown; radial shields pale gray with surrounding scales white; arms pale cream-color; under arm-plates white; no bands, spots or markings on arms or spines.

Holotype, M. C. Z. no. 4961, dredged at Broome, W. A., 5–8 fms., June, 1932.

Besides the holotype, which is so unfortunately imperfect, a single paratype of this remarkable species has been found among the specimens of *Ophionephthys tenuis*, sifted out of the sandy mud near the jetty at Broome, in 1929. This individual is in even worse condition than the holotype; every arm is broken off very near the disk and the longest fragment with the specimen is little more than 10 mm. long. The disk measures only 3 mm. across. The identification is beyond question because of the remarkable arm-spines, but the characters of the oral frame are also notable. The disk skin is brown but all other parts of the specimen are white.

While the arm-spines of this well-marked species resemble those of the Japanese *cenomiotata* more than they do those of *octacantha*, the oral shields and papillae are very different from those of the northern species. The present specimens are probably young for the arm-spines have a more delicate structure than would be expected in a fully adult Ophionephthys.

OPHIONEPHTHYS TENUIS[1] sp. nov.

Disk 5 mm. across; arms 5, exceedingly slender, the length in life probably more than 25 times the disk diameter; in all the preserved specimens more or less broken; in the holotype, one is nearly 100 mm. long with a maximum width of

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[1] *tenuis* = slender, in reference to the very slender arms.

.75 mm. without the spines and rather less than 1.5 mm. including the spines. Disk naked above and below except around radial shields where there are a number of scales along the outer margins and around the inner ends, but there are none along the inner side. Upper arm-plates very wide, much wider than long, rounded pentagonal; proximal margin nearly straight, full width of arm; lateral margins short; distal margins each nearly equal to two of the lateral; distal angle very wide, blunt. At base of arm, the plates are in contact but further out they are narrowly separated by the meeting of the side arm-plates.

Under arm-plates squarish or wider than long, with slightly rounded corners; at base of arm, they are fully in contact but further out are separated slightly by the meeting of the side arm-plates. Arm-spines 5 or 6 at very base of arm, the lowest much the largest and exceeding the arm-segment, the other 4 or 5 very delicate and subequal; soon the number drops to 4 and then to 3; the middle spine of the 3 then becomes thicker and stouter than the others and develops at the tip a minute but distinct, distally directed sharp tooth.

Oral shields, except madreporite, low and very wide; width about 3x the height; proximal margin concave; distal convex. Madreporite very large and nearly circular. In other specimens, the shields are rounded triangular, twice as wide as long, with a rounded distal angle; madreporite diamond-shaped, with rounded angles, distinctly wider than long. Adoral plates of a peculiar shape, difficult to describe; inner (radial) side deeply concave with proximal end more or less prolonged towards the jaw-tip and bearing the outer oral papilla; outer (interradial) side runs straight back to oral shield and then curves in towards the arm, the oral shield resting against the wide rounded angle; a third angle narrow and rounded, brings the inner (radial) corner of the plate against the relatively large first under arm-plate. Inner oral papillae, large and block-like as usual; outer, minute and spiniform, situated, as stated above, on proximal corner of adoral plate. Papilla protecting first oral tentacle, long, blunt and conspicuous.

Color of dry disk very light brown, the radial shields and accompanying plates nearly white; arms dingy white or very pale brown, lightest distally; a very narrow incomplete line of a purplish tint can be made out along the middle of many upper arm-plates indicating a median line of color on the upper side of the arm in life, but it is now very faint. In some of the paratypes this line is more evident and in one it is noticeably wider, but it is never conspicuous.

Holotype, M. C. Z. no. 4963, from the jetty flat at Broome, W. A., September, 1929.

There are 47 paratypes, including one very small one with disk only 1.6 mm.

across and arms less than 20 mm. long. These were all sifted from the muddy sand near the jetty at Broome, where they were found in company with *Ophiocentrus verticillatus*. The alcoholic specimens have the disk more or less puffed out in the interradii, or else are flat and wrinkled; in the largest specimens the disks are 6–7 mm. across. The color shows some diversity for while many are nearly white, some are a light gray while others show a distinct reddish-brown tinge on the arms. My field notes say: "In mud, jetty flat, everywhere. Extraordinarily long arms. Disk light yellow-brown; arms white or occasionally brownish, especially at base."

This remarkable species is obviously related to *phalerata* of the Philippines and *vadicola* of Japan. In the extraordinary length and slenderness of the arms, it resembles *vadicola* but the difference in the oral shields is striking and the arm-spines seem to be much smaller and less numerous. Compared with the holotype of *phalerata*, the specimens of *tenuis* seem much more delicate, the arm spines much smaller and the oral shields wider and lower. Unfortunately there are no specimens of the Japanese species available for comparison.

AMPHIPHOLIS SQUAMATA

Asterias squamata DELLE CHIAJE, 1828. Mem. Anim. s. Vert. Napoli, **3**, p. 74.
Amphipholis squamata VERRILL, 1899. Trans. Conn. Acad., **10**, p. 312.

This cosmopolitan brittle-star was found wherever we collected in Australian waters. My attempt (1909, p. 540) to distinguish the Australian form as a species distinct from *squamata* must, I now believe in the light of more abundant material, be abandoned. A careful comparison of unusually good specimens from Hobart, Tasmania, and Shell Harbor, N.S.W., with similar material from Naples and from the coast of Maine does not reveal any character or group of characters by which they can be distinguished. Further study of paratypes of *australiana* in comparison with specimens of the same size from other places shows that the supposed characters of the southern species are not reliable but are due to immaturity. Whether the South American form described as *laevidisca*, at the same time and place as *australiana*, has any greater validity than that form, is open to serious question but without more material from the western coast of South America, no final decision can be reached.

The Australian material of *squamata* in the present collections consists of 150 specimens from the following localities:

Lord Howe Island: April, 1932. 17 specimens.
New South Wales: Shell Harbor, May 4, 1932. 4 specimens.
Port Jackson, Bottle and Glass Rocks, November 27, 1929. 5 specimens.
Colloroy, Long Reef, November 28, 1929. 59 specimens.
Northern Territory: Coburg Peninsula, Port Essington, Coral Bay, May 21, 1932. 3 specimens.
Darwin, East Point, July, 1929. 6 specimens.
Western Australia: Broome, August and September, 1929. 4 specimens.
Broome, June, 1932. 8 specimens.
Geraldton, October 7, 1929. 2 specimens.
Dongarra, E. W. Bennett leg. et don. 1929. 12 specimens.
Rottnest Island, October 19, 1929. 11 specimens.
Rottnest Island, Bathurst Point, 5 specimens, loaned by Perth Museum.
Bunbury, October 25, 1929. 1 specimen.
South Australia: Port Willunga, November 2, 1929. 1 specimen.
Tasmania: Hobart, estuary of Derwent, November 15, 1929. 11 specimens.
Eagle Hawk Neck. T. T. Flynn leg. et don. 1929. 1 specimen.

AMPHISTIGMA[1] gen. nov.

A genus of Amphiuridae closely related to Amphipholis but readily distinguished by the relatively large spines on the disk. The group may be diagnosed as follows: Amphiuridae with disk covered by very distinct, relatively large scales and radial shields, the latter in a closely joined pair; certain plates, particularly 3 near the disk margin in each interradius, bear relatively large, erect spines. Mouth parts as in Amphipholis, with large adoral plates and 3 oral papillae on each side of each jaw, the outermost wide and opercular. Tentacle scale single on the first few pores, often on only one, wanting thereafter.

Genotype, *Amphistigma minuta* sp. nov.

Were it not for the big spines on the disk these tiny brittle stars could be placed in Amphipholis but the spines are suggestive of Ophiostigma. Comparison with small specimens of that genus however show two obstacles to using the name for the present species. Ophiostigma has 2 tentacle-scales and the disk scaling is obscured by a skin on which small scattered spinelets are borne. So far as mouth parts are concerned Amphipholis, Ophiostigma and Amphistigma are all alike, but in disk covering three quite distinct types occur and Amphistigma is further set apart by the lack of tentacle scales.

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[1] Combination of *Amphi*—(from Amphiura) and —*stigma* (from Ophiostigma) because of the obvious relationships.

AMPHISTIGMA MINUTA[1] sp. nov.

Disk 1.5 mm. in diameter, flattened, but set up well above arm bases; arms 5 (one very small specimen has 6), about 6 mm. long. Disk covered by about 75 well-defined plates, among which the primary plates are conspicuous; the central plate is much the largest but does not have quite so great an area as one of the radial shields; the 5 radial plates are large, hexagonal, the distal half with rounded margins; between the two of each pair and adjoining the central plate is a small interradial scale longer than wide, conspicuous because the distal end is swollen into a rounded knob; primary interradial plates just distal to these knobs about as large as radial plates and with thicker margins; distal to the interradial plate, the area is filled by about a dozen rather thick plates, the outer ones in two ill-defined transverse series of 3 plates each; each plate of the upper of these two series carries an erect tapering blunt spine of relatively large size; the middle spine of the 3 is the largest and its length is nearly or quite equal to the diameter of the central plate; the number, size and position of these interradial spines (fig. 15) shows some diversity; there may be only 2 present or there may be 4, and several may be much smaller than normal, but the group is almost always a conspicuous feature of the interradial areas when seen from above or from the side. Radial shields rather large, rounded triangular, closely appressed on the radial line; length about one-half disk radius, width about half length; outer end swollen and projecting as a small but conspicuous knob. Upper arm plates oval, somewhat swollen, with a proximal angle and a strongly convex distal margin; the first two are in contact and the second and third may be but subsequent plates are separated by the side arm-plates.

Interbrachial areas below covered by a coat of a dozen or more closely appressed scales. Genital slits present but short. Under arm-plates pentagonal; first one very small; second and sometimes the third as wide as long; succeeding plates longer than wide with distal margin a little concave or notched; all of the

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[1] In obvious reference to the very small size of all the specimens as yet seen.

plates are separated from each other by the side arm-plates, which are relatively very large and meet both above and below. Arm-spines 3, short, stout and usually pointed, hardly as long as an arm-segment even at base of arm. Here and there one of the spines, and it may be any one of the three in a series, is enormously swollen, the diameter becoming equal to half the length or more, and the tip may be truncate or rounded; the appearance is pathological but as such spines occur irregularly on most of the specimens, it is probably a normal feature. Tentacle scale single, oval, relatively large; usually evident on the first pair of pores, often on two or even three, but lacking thereafter.

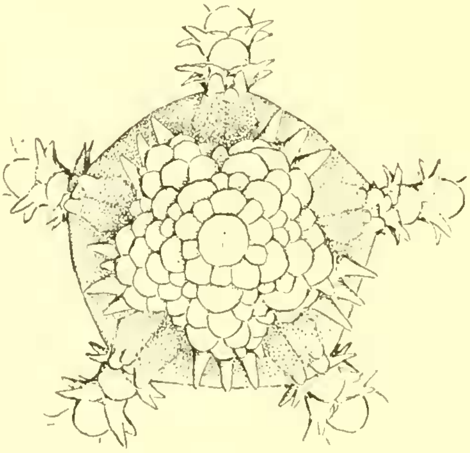

Fig. 16. Amphistigma minuta. Upper surface of disk and arm bases. x 35.

Oral shields rather small, triangular, wider than long; inner angle sharp, outer margin slightly curved; madreporite very large, rounded pentagonal, swollen, as long as wide. Adoral plates large, quadrilateral with rounded angles; inner end narrower than outer; they meet within fully but are separated radially by first under arm-plate. Oral papillae 3 on each side of each jaw; innermost thick and heavy but hardly block-like, second much smaller, thick and knob-like, third and outermost equal to the other two in area covered, thick but opercular, its length equal to about twice its width.

Color of disk and side arm-plates variegated light and dark gray, with a yellowish-green tint on radial shields; all knobs, tubercles, spines and thickened edges of plates, white, often in marked contrast; lower surface pale yellowish fading to white on basal under arm-plates; interradial portions indistinctly speckled or marked with gray, but no sharp markings or contrasts.

Holotype, M. C. Z. no. 4983, found in "weeds" and stones, dredged in 3–4 fms. in the lagoon, Lord Howe Island. April 13, 1932.

This is a very odd little brittle-star which would be completely overlooked in ordinary collecting. But the vegetable and animal material we dredged from the lagoon bottom near Goat Island was put in large basins, covered with sea-water and left standing undisturbed over night. The next morning many small animals were found on the sides or bottom of the basins, and among them were 13 of these very small but unusually interesting amphiurans which were supposed at the time to be young Ophiostigmas. The colors in life were variegated, with browns and whites predominating and some red on arms; sometimes there was a spot of deep red on the disk. These brighter tints have all disappeared in the preserved material. No specimens were taken along shore but owing to their minute size and secretive habits, it would be almost impossible to discover them, except by letting material stand in water until decreasing oxygen forced the animals out. Although this was tried, no further specimens of Amphistigma were secured.

AMPHIODIA OCHROLEUCA

Amphiura ochroleuca BROCK, 1888. Zeit. f.w. Zool., **47**, p. 484.
Amphiura brocki DÖDERLEIN, 1896. Denk. Ges. Jena, **8**, p. 286.
Amphiodia mesopoma H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 247.
Amphiodia ochroleuca H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 250.

When the description of *A. mesopoma* was published, the possible identity with *ochroleuca* and *brocki* was suggested. Some years later (H. L. Clark, 1928, p. 426) specimens of *mesopoma* were reported from Spencer and St. Vincent Gulfs, South Australia, as well as from Westernport, Victoria. Koehler, who has examined and figured (1904, p. 63) Brock's type of *ochroleuca*, has recently (1930, p. 105) reported a specimen of that species from "Port Western, Australia." Presumably this is Westernport, Victoria, whence came some of the specimens of *mesopoma* in the M. C. Z. Under the circumstances, there can no longer be any doubt of the identity of the species described by Brock, Döderlein and myself. That so widespread a species should show some diversity in color and in length of arms is not surprising; the close resemblance of all the known specimens in structural details, especially mouth parts, is more remarkable.

It is interesting to report that *ochroleuca* ranges westward from Torres Strait, as well as to the southern coasts of Australia. At Darwin, 2 specimens were dredged near the Shell Islands, in July, 1929, and another specimen was taken near the Leper Station, in May, 1932. At Broome 2 specimens were collected in 1929 and 2 in 1932. All of these 7 specimens agree well in structural details but show striking diversity in color. Young individuals with disks only 4 mm. across or less, have the radial shields more or less in contact; the shields are relatively larger, the disk flatter and more pentagonal, the disk scaling somewhat coarser than in larger specimens. But on the whole, the growth changes are insignificant. None of the specimens seen by me are as large as Brock's type which was 9 mm. across the disk, nor are the arms nearly as long — Brock says 10 times the disk-diameter. As a rule, Australian specimens have the arms 5–6 times the disk diameter, but in some specimens they are longer; in one from Darwin with a disk about 4 mm. across, the arms exceed 30 mm.

In the matter of color there is puzzling diversity. In a dry specimen from Darwin and in the smallest one from Broome, the disks are light gray, while the arms are nearly white, with many irregularly scattered upper arm-plates, greenish-, or brownish-yellow. For these and similar but larger specimens, in the M. C. Z., from Westernport, also dry, the name *ochroleuca* is very appropriate. The southern specimens have the arms very definitely yellow and white. Specimens in the M. C. Z. from South Australia are now very dingy but evidently had a similar color in life. The remaining specimens, 2 from Darwin and 3 from Broome although also dry, are very different at first sight, because the arms are conspicuously banded. The disks are more or less tinged with yellow, in one large specimen very considerably. The arms are whitish but some upper arm-plates are dusky in sharp contrast to their neighbors, giving the banded appearance to the arms, which is of course entirely lacking on the uniformly white oral surface. The number and position of the dusky plates shows great diversity; near the base of the arm they may be near together, every second or third plate being dark, but further out there are often 4 or 5 white plates between the dark markings. Usually the dusky mark consists of a single plate, but frequently there are 2 together and rarely 3. In addition to the banding, all of these conspicuously marked specimens have a more or less faint longitudinal line on the upper side of the arm, most evident distally; in some specimens this line is reddish, in others a light brown. The arm-spines are white, sometimes unmarked but usually with a touch of dusky.

Brock (1888, p. 485) says: "Farbe hell braungelb mit besonders auf dem Scheibenrucken stark ausgepragtem Stick ins olivengrune. Die groseren Schilder des Scheibenruckens sind etwas dunkler gefarbt als ihre Umgebung, die Ruckenschilder der Arme unregelmassig dunkler marmorirt. Die ganze Bauchseite hell, ockergelb, die Stacheln fast weiss, mit gelbem Ring um die Basis." Unfortunately there is no hint as to whether this is a description of the color in life or after preservation; if after preservation, was the specimen dry or in alcohol? Koehler (1904) throws no light on the matter, though he studied and figured Brock's type. In any case, no Australian specimen of *ochroleuca* has any such coloration either in life or after preservation, and it is for this reason, I have hesitated to call them by Brock's name. Döderlein's description of the color of *brocki* is more satisfactory for he says (1896, p. 287): "Farbe der Ruckenseite blassgleb, Bauchseite weisslich, Arme gebändert, indem mit je 2–4 weissen Ruckenplatten, 1–2 gelb gefärbte abwechseln." Of the Darwin specimens, my 1929 field notes say: "Disk buff gray, arms banded, the light bands with a pink tinge." The specimens were "found in rock crannies, among sponges, etc." At Broome the species was found under a rock at Gantheaume Point and my notes say, "Color well kept but was a bit more pink in life."

Both Brock and Koehler emphasize the fact that the second oral papilla on each side of the jaw is the largest, and Brock says it is twice as wide as high. Koehler does not show it so although using Brock's own specimen for his figure and my specimens agree very well indeed with Koehler's illustrations.

AMPHIOPLUS DEPRESSUS

Amphipholis depressus LJUNGMAN, 1867. Öfv. Kong. Vet.-Akad. Förh., **23**, p. 312.
Amphioplus depressus H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 254.

A very fine specimen of this well-marked species was dredged at Darwin, near Channel Island, July 18, 1929, but we did not meet with it in the Broome region. Mortensen took a specimen at Amboina of which Koehler (1930, pl. XVII, figs. 13 and 14) has given two excellent figures. My field notes say: "Creamy white below; disk gray; upper surface of arms gray with a greenish tinge; each plate however is lighter on margins and also more or less light at center. Arms wide at base but narrowing rapidly and becoming extremely attentuate." The dry specimen is 6 mm. across the disk, which is gray; the arms still show clear indications of the variegated shades present in life.

AMPHIOPLUS LUCIDUS

KOEHLER, 1922. Bull. 100 U. S. Nat. Mus., **5**, p. 176.

While digging brittle-stars, spatangoids and holothurians out of the teeming mud of the flat south of the jetty at Broome, during the low tide of September 17, 1929, a long-armed amphiuran was secured which was at once seen to be different from anything that had previously been taken. Unfortunately it very promptly broke its arms into pieces and shed its disk but the latter was preserved with the arms and oral framework and proves to be of great importance as the first disk of *lucidus* which has been preserved. In June of 1932, we dredged a second specimen but like all of the previously dredged specimens, reported on by Koehler (1922, p. 176, 3 specimens and 1930, p. 106, 4 specimens), the disk was shed in the dredge and lost.

A careful comparison of the Broome specimens with Koehler's original description and figures leave no doubt of their identity. They are not exactly like each other, for the 1929 specimen is apparently younger, (it was about 7–8 mm. across the disk in life) and has oral shields much like those of Koehler's figure 6, while the 1932 specimen is like figure 7. In both individuals the tentacle-scales are minute but they are more conspicuous in the younger specimen; in the older one they tend to disappear distally. The disk of the 1929 specimen was covered with a thin skin (now brown in color), the only scales present being close around the radial shields as in Ophionephthys. The shields are well developed, almost 2 mm. long but not quite half a millimeter wide. Koehler makes no reference to color but the Broome specimens show some features which seem to me important especially as there are hints of the same in Koehler's photographs. In the smaller specimen, the arms were about 60 mm. long in life; the best fragment is about a millimeter wide; the arms are yellowish-white at base becoming white distally; along the dorsal side is a narrow median line of dusky brown, repeatedly broken and hence incomplete; every 3 or 4 plates, there are dusky markings on one or two of the upper arm-plates; distally these are evident enough to suggest that the distal half of the arms is banded. The lower surface of the oral frame and arms shows no dusky markings but each under arm-plate on the proximal portion of the arms is tinged with light reddish. In the larger specimen of 1932, in which the arms probably exceeded 100 mm., these color characters are accentuated. The proximal portion of the arms is brownish-white, there is much more dusky on the arm-plates and some spots of brown on the arm-spines; the arms appear more or less definitely, if not sharply, banded; the red tint on the proximal under arm-plates is very marked and extends onto the side arm-plates and the oral frame. On many of the lowest arm-spines there is a conspicuous brown spot on the oral side of the basal part and similar spots occur on many spines of the series above the lowest.

There is no doubt that species of Amphioplus of this type, such as *cyrtacan-*

thus H. L. C. and of Ophionephthys such as *stewartensis* Mrtsn. are congeneric as Mortensen (1924) suggests but the question involves so many non-Australian species, it cannot be entered into here.

Amphioplus relictus

Amphiura relicta Koehler, 1898. Bull. Sci., **31**, p. 68.
Amphioplus relictus H. L. Clark, 1915. Mem. M. C. Z., **25**, p. 256.

We first met with this apparently common and widespread East Indian species at Darwin where a single small specimen was "sifted out of sand at East Point," June 27, 1929. My field notes say: "disk quite green, arms greenish and dusky." Later it proved to be not uncommon at Broome and finally we discovered it at Point Peron, below Perth. As it was taken at Goode Island in Torres Strait in 1913 (H. L. Clark, 1921), it evidently occurs along the entire northern and western coasts of Australia but it is not yet known from the eastern or southern coasts.

The present series ranges from young specimens 2.5–3 mm. across up to an adult specimen 6 mm. in disk diameter. The arms are apparently much longer relatively in young individuals than in the adults, for specimens 3 mm. or less across have the arms about 8 times the disk diameter while in specimens 4.5–6 mm. across, the arms are only 4–5 times the disk diameter. Another peculiarity of small specimens is the delicate character of the disk scales, which seem smaller and more numerous in very young individuals. After the disk is 4 mm. across the scales thicken up and the covering is more compact. At all ages however there is an evident sharp horizontal margin to the disk where the scales of the oral interbrachial areas come against the marginal scales of the disk. There is some diversity in the relative width of the radial shields but it is not very notable. All the specimens have the disk more or less gray, the arms more or less white.

The 17 specimens at hand were taken as follows:
Northern Territory: Darwin, East Point, June 27, 1929. 1 specimen.
Western Australia: Broome, August-September, 1929. 3 specimens, young.
Broome, 5–7 fms., June, 1932. 12 specimens, adult and young.
Point Peron, October, 1929. 1 specimen.

AMPHIOPLUS DIDYMUS[1] sp. nov.

Plate **14**, fig. 3

Disk 5 mm. across, flat, deeply notched in interradii, much less so over the arms, which are 5 in number and 50–55 mm. long. Disk covered with a coat of small but rather thick scales among which the primary plates are not distinguishable; around entire margin of disk but most conspicuously in the interradii, the scales are very much smaller and overlap towards the disk center. Radial shields very small (1.25–1.5 mm. long), narrow (width scarcely one-third length), separated a little from each other except at distal tips. Upper arm-plates short and wide, the width about 3 times the length, with distal corners very lightly rounded. Arms narrow at base (less than a millimeter, not including spines) but becoming rapidly wider (over a millimeter) and then tapering gradually to an attenuate tip; in accordance with this, the basal arm-plates are scarcely twice as wide as long and distally also the plates are not only actually but relatively much narrower and longer.

Interbrachial areas below closely covered with a dense coat of very fine scales. First under arm-plate rather small, triangular with an inner point, or four-sided, the inner angle being truncated; the next two or three plates squarish but longer than wide; subsequent plates square or wider than long until distally as they decrease in size they again become longer than wide. Side arm-plates small, bearing three short (one-half a millimeter or less) divergent spines, of which the upper and lower are rather thick basally but bluntly pointed, while the middle one, although longest, is relatively very stout, abruptly truncate, with an evident hyaline tooth at each corner, one pointing towards mouth, the other towards arm-tip; at base of arm, a small fourth spine occurs above the normally uppermost. Tentacle-scales 2, very large; the one attached to under arm-plate occupies nearly the whole lateral margin; the one on side arm-plate is somewhat smaller.

Oral shields elongated pentagonal with all angles rounded; length much greater than width; inner angle blunt, outer side short; madreporic plate larger and relatively wider than the others. Adoral plates of moderate size, with rounded angles, meeting within but separated distally by first under arm-plate. Oral papillae 4 on each side, the innermost block-like one much the largest; of the 3 following scale-like papillae the middle one is largest and is more or less markedly truncate on its free margin.

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[1] *δίδυμος* = *double*, in reference to the conspicuous double point on the middle arm-spine.

Color of dry specimen; disk gray, the marginal portions with a yellowish tinge; arms very pale yellowish, the tips and spines nearly white; many upper arm-plates on distal half of arm have faint blotches of pale reddish-brown, but these would be easily overlooked without careful examination.

Holotype, M. C. Z. no. 4993, found by A. A. Livingstone, under a rock five or six hundred yards south of jetty, Broome, W. A., August 29, 1929.

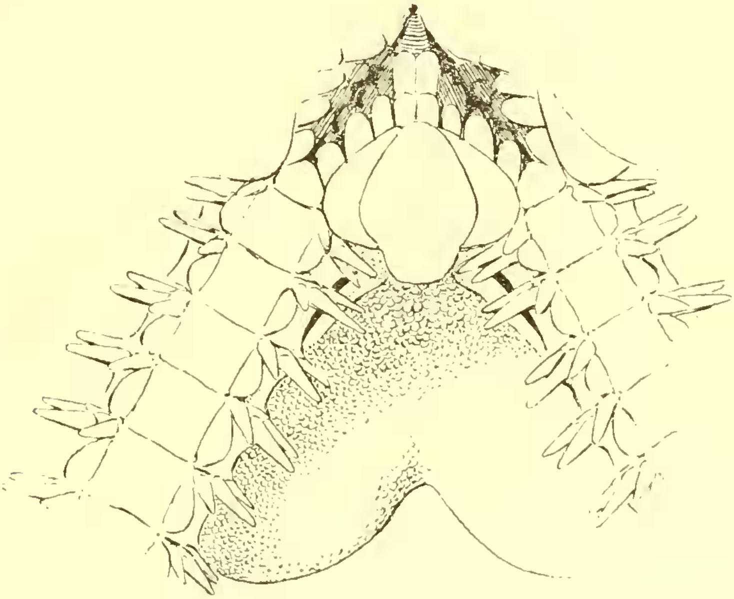

Fig. 17. Amphioplus didymus. A mouth angle and bases of adjoining arms. x 20.

Besides the holotype, a somewhat smaller paratype was dredged July 5, 1929, near the Shell Islands, Darwin. It resembles the specimen from Broome in all particulars but the disk is detached and hence contracted to a different form. Of this specimen my field notes say: "with a sponge on a bit of rock; disk gray with a little red in spots; arms bright yellow with numerous irregular vermilion red markings; arm-spines gray at base, nearly white distally. Disk was shed soon after capture. The most strikingly colored brittle star yet seen." The holotype was similar in color, my notes saying: "Arms yellow and bright red; disk covered with silt but when brushed off with a camel's hair brush, it was found to be light greenish-yellow, gray on and around radial shields." The arm-spines and tentacle-scales are unmistakable recognition marks for this beautiful brittle-star.

Amphioplus stenaspis[1] sp. nov.

Disk 6 mm. in diameter, pentagonal, with distinct radial notches and less evident ones in the interradii. Arms 5, about 50 mm. long, narrow at base, widest at 10–15 mm. from disk and then tapering to an attenuate tip. Disk covered with a coat of small but rather thick overlapping scales among which the primary plates are not to be distinguished; in smaller specimens the central and 5 radial plates are sometimes quite distinct. Radial shields (fig. 18) exceptionally long and narrow; the inner end tapers to a very fine point; the outer end is truncate; the 2 shields are about 1.5 mm. long and lie nearly parallel but are rather more widely separated within than distally where they are almost in contact. Upper

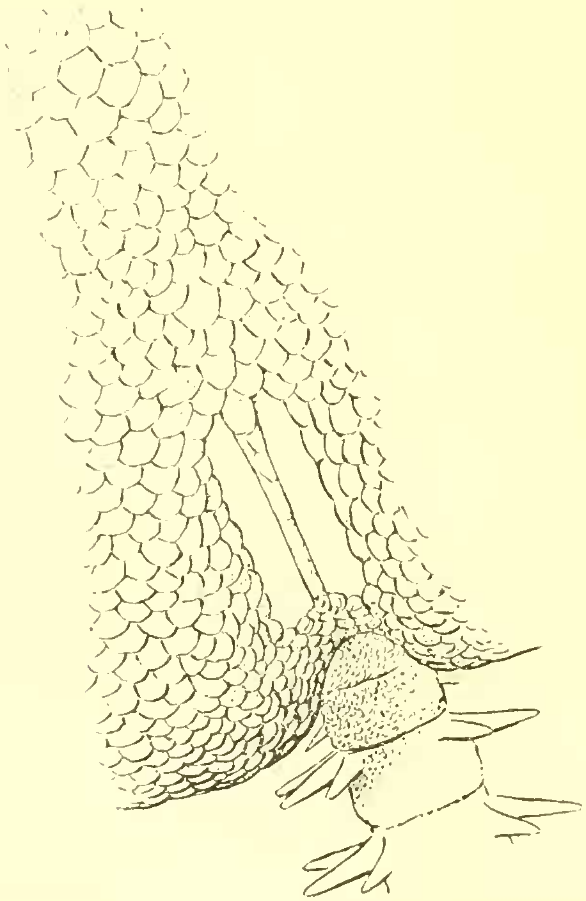

Fig. 18. Amphioplus stenaspis. x 20. Base of an arm and adjoining portion of disk to show radial shields.

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[1] $\sigma\tau\epsilon\nu\acute{o}\varsigma$ = *narrow* + $\grave{\alpha}\sigma\pi\acute{\iota}\varsigma$ = *shield*, in reference to the very narrow radial shields.

arm-plates about 3x as wide as long, with a rather straight margin and rounded corners distally, in contact for their full width.

Interbrachial areas below (fig. 19) covered with a coat of scales similar to those on the dorsal side but considerably smaller. Under arm-plates squarish or wider than long, broadly in contact; some plates approach a broadly pentagonal form, the proximal margin being a wide angle instead of a straight line; in such cases only the angle is in contact with the distal margin of the preceding plate. Side arm-plates small and low, carrying 3–5 short, blunt arm-spines; beyond the basal 15–20 arm-segments there are only 3 spines, which are subequal and scarcely exceed the short segments; basally there are 4 spines and close to the disk there are 5, the lowest and uppermost longest, the intermediate ones being appreciably smaller. Tentacle-scales 2, one on the side arm-plate and one on the under arm-plate, at right angles to each other.

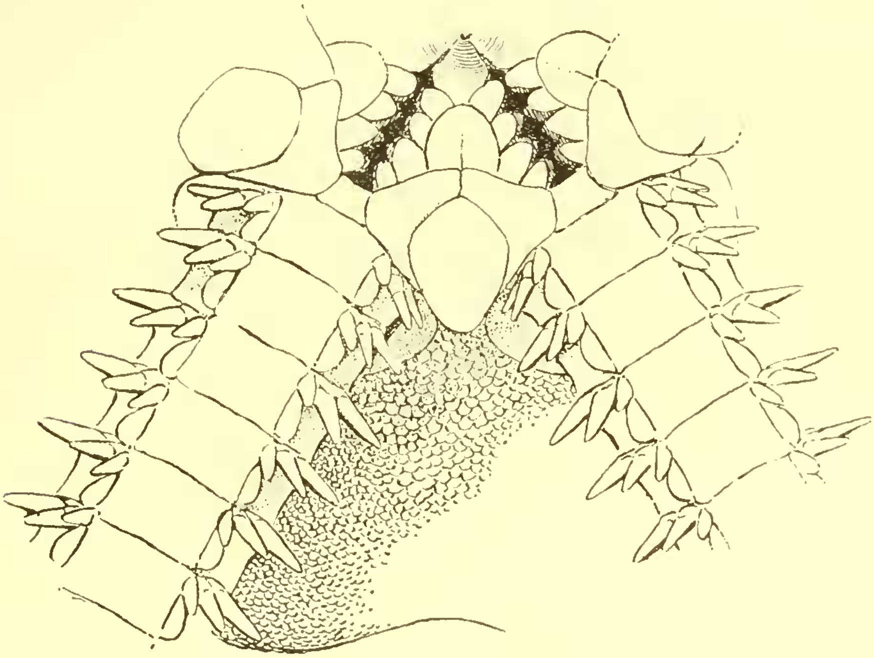

Fig. 19. Amphioplus stenaspis. x 20. Bases of 2 arms with adjoining mouth parts and portion of disk.

Oral shields distinctly longer than wide, the distal end pointed or somewhat truncate, the other 3 angles more or less rounded; madreporic plate largest and most rounded. Adoral plates not very large, triangular, just meeting within but well separated radially by the first under arm-plate. Oral papillae 4 on each side of each jaw; the usual block-like one at tip of jaw is followed closely by 3 small scale-like papillae of which the middle one is a little the largest but is somewhat pointed while the other two are more truncate.

Color of dry specimen; disk gray; arms pale brownish; lower surface and arm-spines more nearly white.

Holotype, M. C. Z. no. 4990, from the sand under a rock-fragment at Night Cliff, Darwin, N. T. June 28, 1929.

This is a very distinct and notable amphiuran, for while it belongs in the same group with *laevis, lobatus* and *lobatodes*, it is easily distinguished from all by the exceedingly narrow radial shields, the very short arm-segments and the correspondingly short and blunt arm-spines. Besides the holotype, there are 8 paratypes, smaller than it but not notably different save that the species characters are not so sharply evident; the radial shields, for example, are not quite so narrow. All were found in a rock-fragment secured on Three-and-a-half mile Reef in Port Darwin, June 24, 1929. This rock-fragment was picked up from a little below low water mark and left in a pail of water over night. In the morning, the 8 specimens of Amphioplus were found dead in the bottom of the pail, 6 having shed their disks. Decreasing oxygen led to their coming out from the crannies of the rock where their presence had not even been suspected. The colors in life were not any more conspicuous than are the grays and browns of the dry specimens.

OPHIACTIS LUTEOMACULATA

H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 263.

It was interesting and not a little surprising to find this species common in the Broome region, as we did not find it at Darwin. In 1929, 11 specimens were secured, 2 being dredged in Lagrange Bay, the others on Pearl Shoal and in Roebuck Bay. In 1932, 80 specimens were taken at numerous stations along the coast between Beagle Bay and Lagrange Bay. The largest specimen (taken in 1929) has the disk 4 mm. across and the arms 10 mm. long, but in the great majority the disk is only 2–3 mm. in diameter and the arms are relatively longer. In the lot secured in August and September 1929 (early Spring), there are 3 (more than one-fourth) six-armed specimens, the smallest specimens secured; in none does the disk measure 2 mm. across. In each case, this very young specimen has recently undergone autotomous division and 3 of the arms form a group on one side of the body noticeably smaller than the other trio. These three specimens agree in practically all particulars with a similar young one taken from the spines of Prionocidaris on the coast of New South Wales and mentioned in the "Endeavour" Report (H. L. Clark, 1916, p. 87). Among the 80 specimens taken in June, 1932 (winter), not a single 6-rayed specimen is to be found and few are less than 2 mm. in disk-diameter. Whether these facts have any significance with reference to the breeding season of this brittle-star remains to be demonstrated, but it seems to be quite possible.

The diversity in color shown by these Broome specimens of *luteomaculata* is very great. Small specimens are dusky-greenish and whitish but many lack any green tinge and are brownish or yellowish in general tone. Large specimens frequently have the disk bright yellow, but in one specimen it is rather bright rose-purple, and in another the disk and basal upper arm-plates are purplish-dusky with a white star at center of disk. The dusky spot on the arm-spines is not always present, though commonly evident. The oral shields usually have a faint dusky blotch at the distal margin.

OPHIACTIS MODESTA

BROCK, 1888. Zeit. f.Wiss. Zool., **47**, p. 482.

Previously known from Amboina and Thursday Island, it is interesting to find that this handsome Ophiactis ranges along the northern coast of Australia from Darwin to Lagrange Bay. Most of the specimens at hand are from Broome however, where we dredged them at various points in 1932. We took but 1 specimen in 1929, when we did much less dredging. The best specimens at hand were found in corals at Cape Leveque; one of these is 7 mm. across the disk and the arms are nearly 60 mm. long. Several adult specimens from Broome have very short arms; one with a disk exceeding 5 mm. has arms less than 20 mm. long. Critical examination however shows that all the arms have been broken off at some time and the terminal portions are regenerated. The handsome coloration of this species (variegated green and yellowish white) tends, in these dry specimens, to one of two forms; in one, the disk is dark bluish-green, with cream-white chiefly on or near the distal part of the radial shields and the arms with much bluish-green or dusky green; in the other, the disk and arms are a dull cream-white, tinged and marked more or less evidently, with a dull green. In the light form, the banding of the arms becomes very marked, but except distally is confined to the upper surface. In one young individual, the disk is speckled with a deep blue and the banding of the arms is deep blue alternating with dull green, and white segments between the colored ones; this is the most brightly colored specimen seen, but several small ones approach it. The large specimens from Cape Leveque are the dark form with blue-green only on the distal part of arms.

Several specimens show autotomous division. The most interesting case is a very small individual less than 2 mm. across the disk, with 2 arms about 14 mm. long and 3 less than 3 mm. There are 2 other young specimens, each with 3 normal arms on one side of the disk and 3 much smaller ones opposite. There is a small adult individual, 4.5 mm. across the disk, which seems to be symmetrically hexamerous, while another specimen of about the same size has 6 arms but only 5 pairs of radial shields; the arm not supported by radial shields is smaller than the others; there are 6 jaws but they are not of equal size. All of the remaining specimens are symmetrically pentamerous. There can be no doubt I think that *modesta* is one of the species of Ophiactis in which the normal number of arms is 5 but in which the very young individuals, very often if not always, have 6 arms.

The 24 specimens of *modesta* at hand are from the following places:

Northern Territory: Darwin, near Shell Islands, July, 1929. 1 small specimen.
Darwin, at Quail Island, July, 1929. 1 specimen, small and very light colored.
Western Australia: Cape Leveque, August, 1929. 4 specimens.
Broome, June, 1932. 17 specimens, adult and young.
Lagrange Bay, September, 1929. 1 specimen, hexamerous.

OPHIACTIS PROFUNDI var. NOVAE-ZELANDIAE

MORTENSEN, 1924. Vid. Med., **77**, p. 128.

A small 6-rayed Ophiactis, belonging to the Australian Museum, is apparently this form. Comparison with cotypes, sent to the M. C. Z. by Dr. Mortensen, shows no differences of any significance. Whether *profundi* should be maintained as distinct from *plana* and other allied forms is still debatable but need not be discussed here. The specimen at hand was taken by Livingstone and Fletcher, in 1922, 3–4 miles off Eden, N. S. W., in 25–30 fms. It is about 2.5 mm. across the disk.

OPHIACTIS RESILIENS

LYMAN, 1879. Bull. M. C. Z., **6**, p. 36.

This characteristic Australian species has a much wider range than has hitherto been supposed. Mortensen (1924, p. 124) has decided that *O. nomentis*

Farquhar, the New Zealand form, is not valid but is really identical with that of Australia. The present collection shows that the range of *resiliens* westward is around the southwestern corner of Australia and north to Rottnest Island.

The color in life is a more or less deep greenish-gray or grayish-green variegated with white or yellowish. This is well kept in many dry specimens but the dark shades often disappear or change to brown in alcohol. The distal tips of the radial shields are white or whitish in sharp contrast to adjoining dark color and this "recognition mark" is frequently conspicuous in good material. Some specimens are brown (especially on the arms) rather than gray or green. The banding of the arms is very irregular but often distinct, particularly distally and in young individuals.

All of the specimens at hand have 5 arms and the smallest specimens with disks 2 mm. or so in diameter, show no indication of autotomy. Apparently *resiliens* does not have a 6-armed stage.

The 40 specimens at hand are from the following places:

Lord Howe Island: Neds Beach, in coral and under rocks, April, 1932. 9 specimens, none large.

New South Wales: 15 miles northeast of South Head, Port Jackson, 75–80 fms., May, 1924. C. W. Mulvey leg. 1 specimen, loaned by Australian Museum.

About east of Ulladulla, 35°20′S x 150°47′E, 74 fms. May, 1924. C. W. Mulvey leg. 1 small specimen, loaned by Australian Museum.

Colloroy, Long Reef, November, 1929. 1 specimen.

Port Jackson, off Middle Head, 4–6 fms., November 21, 1929. 14 specimens, adult and young.

Port Jackson, Bottle and Glass Rocks, November 27, 1929. 2 specimens.

Shell Harbor, May 4, 1932. 5 specimens.

Victoria: Port Philip. J. A. Kershaw leg. 2 specimens, large. Loaned by Melbourne Museum.

Western Australia: Great Australian Bight western end, 33° 15′S x 126° 22′ 15″ E, 90 fms., Feb. 23, 1930. D. L. Serventy leg. E. W. Bennett don. 4 specimens.

Rottnest Island, Cape Vlaming, in seaweeds, February, 1930. Swan and Drummond leg. E. W. Bennett don. 1 large specimen.

OPHIACTIS SAVIGNYI

Ophiolepis savignyi Müller and Troschel, 1842. Syst. Ast., p. 95.
Ophiactis savignyi Ljungman, 1867. Öfv. Kongl. Vet.-Akad. Forh., **23**, p. 323.

The tropicopolitan distribution of this little ophiuran is well emphasized by its Australian range. From Lord Howe Island and Port Jackson, northward to Torres Strait, westward to Darwin and thence southwestward and south to Cape Leveque, Broome, Dongarra and Rottnest Island — everywhere that collections were made, *savignyi* could be counted on to be in the spoil. But from Perth southward around Cape Leeuwin and eastward to Tasmania and southern New South Wales, not a single individual has yet been reported.

The 301 specimens at hand were taken at the following places, reference being made to any notable facts in connection with each lot.

Lord Howe Island: in and under patches of sponge and in similar hiding places, April, 1932. 90 specimens. The largest has the disk 5 mm. across. Many of those about 2 mm. across show evidence of recent autotomy. Only 1 individual has 5 rays, a small specimen a little more than 2 mm. across disk. Many of these specimens are distinctly brown and whitish rather than green and white. My field notes say: "Usually very brown with no green; all 6-armed; none big; 1 adult had many young hanging about it."

New South Wales: Port Jackson, Bottle and Glass Rocks, November 27, 1929. 1 small but typical hexamerous specimen; very dark green coloration.

Queensland: Port Curtis. Melbourne Ward leg. 35 specimens. Loaned by Australian Museum. This series ranges from young ones a millimeter across the disk to large adults 8 mm. in diameter. All the adults are 5-armed but nearly all those with disks less than 3 mm. across are 6-armed and many show obvious indication of autotomy.

Northern Territory: Coburg Peninsula, May 20–22, 1932. 13 specimens. At Smith's Point, Coral Bay and Allaru Island, collecting was done and *savignyi* was found at all 3 places. My field notes say: "they had the disk distinctly brown but the arms green and white." No really adult specimens were collected; the largest is a symmetrically 7-rayed individual, a little more than 4 mm. across the disk. All of the other specimens have 6 arms, not a single 5-rayed individual being taken.

Darwin, East Point, June, 1929. 50 specimens, mostly small, nearly all, including the largest (5 mm. across disk), with 6 arms.

Darwin, West Point, June, 1929. 3 hexamerous small adults.

Darwin, dredged in 3–6 fms. near Shell Islands, July, 1929, sponge and alcyonarian bottom, 12 specimens, adult and young; of 6 adults, 4–6 mm. across disk, 1 has 6 arms, the others 5; of 6 young, 2–3 mm. across disk, 4 have 6 arms, 2 have 5.

Darwin, near Leper Station, May, 1932. 4 specimens, 2 pentamerous adults, 2 hexamerous young.

Quail Island, west of Darwin, July 7–9, 1929. 7 specimens, 2 large 5-armed adults, 6–7 mm. across disk, 4 smaller 6-armed adults and 1 small individual with 6-arms but only 5 pairs of radial shields.

Western Australia: Cape Leveque, August, 1929. 6 hexamerous young specimens.

Broome, August and September, 1929. 10 specimens, 1 pentamerous adult and 9 hexamerous young.

Broome, June, 1932. 49 specimens; 8 large pentamerous adults and 3 pentamerous young; 38 hexamerous specimens, mostly young but a few small adults.

Lagrange Bay, September, 1929. 3 small specimens, the largest pentamerous and quite brown.

Dongarra. E. W. Bennett, leg. et don. 8 specimens, hexamerous young.

Rottnest Island, Cape Vlaming, "in sea-weed," February, 1930. Swan and Drummond leg. E. W. Bennett don. 10 very small hexamerous specimens.

OPHIACTIS SAVIGNYI var. LUTEA var. nov.

Similar to ordinary *savignyi* but strikingly different in color. My field notes say: "Found in tide-pool at Quail Island (west of Darwin, N. T., July 9, 1929) in a pure white sponge. Arms bright yellow, disk bright brown. Otherwise like *savignyi* of which it may be only a color form. About a dozen specimens found. Habits, etc. like *savignyi*."

There are 10 specimens at hand, ranging from very small ones with disk about a millimeter across to the holotype (M. C. Z. no. 5038) a very perfect adult, 4.5 mm. across disk, with arms 22 mm. long. The 2 smallest have only 5 arms, the others all have 6. In their present dry condition they look like very pallid, one might say bleached, *savignyi*.

OPHIACTIS TRICOLOR

H. L. CLARK, 1928. Rec. S. Austral. Mus., **3**, p. 427.

A small brittle-star loaned me by the Melbourne Museum proves to be an example of this species. It is only 3 mm. across the disk and the coloration is rather faded but the red, white and blue of the arms is still evident. It was taken in 40 fms. north of Cape Borda, Kangaroo Island, South Australia.

OPHIACTIS ACOSMETA[1] sp. nov.

Disk 3 mm., across. Arms 6, about 12–14 mm. long. Disk covered with rather coarse scales and 6 pairs of moderately large, well-separated radial shields; the shields in each pair are in contact, if at all, only at the extreme distal tips. Upper arm-plates broadly fan-shaped much wider than long, the proximal angle more or less truncate, according to the degree in which the plates are in contact with each other which is usually considerable; distal margin a little convex and lateral angles slightly rounded.

Interbrachial areas below well covered with a few large scales. First under arm-plate small, longer than wide, diamond-shaped or pentagonal by the truncation of the inner angle; second plate wider than long with lateral margins straight and nearly parallel, proximal margin with a very slight median angle and distal

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[1] *ἀκόσμητος* = *unadorned*, in reference to its dull color and lack of distinctive marks.

margin barely convex; third plate about as long as wide, with slightly divergent lateral margins, the distal margin longer than the proximal and more nearly straight, the outer corners rounded; subsequent plates wider than long for 7 or 8 plates then becoming longer than wide, more or less squarish or pentagonal with a proximal angle, with rounded corners, slightly or not at all in contact. Side arm-plates large, often meeting each other on oral side, and on distal half of arm, dorsally also. Arm-spines 3 in a series, 4 on a few basal segments, the middle one largest and bluntest, the lowest one smallest but stout at base and sharp at tip, the uppermost (when 4 are present, next to uppermost) longest and least stout, about equal to an arm-segment. Tentacle-scale single, of moderate size.

Oral shields rounded triangular about as wide as long or wider; madreporite not conspicuously larger than the others. Adoral plates rather large, the inner end narrow and not quite meeting its fellow within, the outer end wide and meeting its fellow radially on 3 arms but not quite doing so on the other 2. Oral papillae single, small, oval, flat but thick, attached by the narrower end to the oral plate just at the inner end of the adoral plate.

Color of dry specimen, brownish-gray, lighter on oral surface; disk faintly variegated, the distal ends of the radial shields and many disk scales being lighter than the rest of the surface.

Holotype, M. C. Z. no. 5045, from Dongarra, Western Australia, E. W. Bennett leg. et don.

There are 23 paratypes but none are larger than the holotype and nearly all are much smaller. Those from Dongarra resemble the holotype in color as well as structurally but those from Broome are much lighter colored and have a tendency to show longitudinal markings or cross-bands of dusky, or brown of some shade on the arms. They show little diversity in structure but one of the largest and lightest colored has the arm-spines a little longer and more slender and a very few spinelets are present in the interradial portions of the disk nearly all below the margin. The specimens from Port Curtis are all small but almost exactly like those from Dongarra in color as well as in structure. That autotomy occurs frequently if not regularly is shown by a number of specimens, 3 arms on one side being much smaller than the other 3. A rather remarkable peculiarity is that in several specimens, including one or two of the largest, there are only 5 pairs of radial shields, although six arms are present in every specimen.

This little Ophiactis is very perplexing, it is so similar in a general way to *plana*, *profundi* and that group of species. But when compared with them, it is evident that there are obvious, if intangible, differences. The most noticeable and constant is in the adoral plates which in the *plana* group are long and narrow and meet fully within, as is well shown by Mortensen (1924, p. 129). There is no danger of confusing *acosmeta* with any other Australian species of Ophiactis. Apparently it may be found anywhere on the tropical coast of the continent for the 27 specimens at hand are from the following widely separated localities.

Lord Howe Island: April, 1932. 1 specimen, young and hence somewhat dubious.
Queensland: Port Curtis. 5 specimens, all young. Loaned by Australian Museum.
Western Australia: Broome, 5–8 fms., June, 1932. 14 specimens, adult and young.
Lagrange Bay, September, 1929. 1 young specimen.
Dongarra. E. W. Bennett leg. et don. 5 specimens, 2 adult.
Rockingham, Cymodocea beds, 4–5 feet, February 9, 1932. E. W. Bennett leg. et don. 1 specimen, young.

OPHIACTIS BREVIS[1] sp. nov.

Disk, 3 mm. in diameter; arms 5, 10–15 mm. long, rather stout at middle, narrower at base, and slender distally; careful examination shows that all the arms are regenerating distally. Moreover it is evident that the disk is also in process of regeneration; the one which had been shed was about 5 mm. across. It is probable that the arms are, in a normal individual about 3 or 4 times the disk diameter. Disk covered chiefly by the very large smooth, radial shields, which are 1.25 mm. long and .75 mm. wide near middle or distal thereto; remainder of disk covered by very small scales, forming a slender column 1–3 scales wide in the interradii, and with 2 scales separating the inner ends of the radial shields from each other; most of the larger scales carry erect relatively large but actually very small spinelets, most numerous on the interradial portions of the margin. Upper arm-plates on middle of arm elliptical wider than long, notably thick, with a finely pebbled or shagreen-like surface, broadly in contact; basally they are more nearly circular or irregular in shape and it is evident that some, perhaps many, are being regenerated; distally they also become more nearly circular or the length may exceed the width; a peculiar triangular white mark leads to the impression that many distal plates are themselves triangular, which is not the case.

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[1] *brevis* = short, in reference to the short arms and short arm-spines.

Interbrachial areas below well covered with rather large scales. First under arm-plate small, more or less hidden by the adoral plates; second plate largest of series, quadrilateral, but distal margin much wider than proximal, somewhat convex, lateral margins a little concave; succeeding plates somewhat octagonal with rounded angles, wider than long, or width and length equal at first, but soon becoming longer than wide; at middle of arm, the proximal margin is very short; the lateral margins are of two parts, straight divergent proximal halves, less straight but parallel distal portions; distal margin of plate strongly convex or more commonly of three parts with rounded angles; near tips of arms, under arm-plates, much longer than wide with rounded angles; individual diversity among the under arm-plates is disconcertingly great. Side arm-plates relatively large but not meeting either above or below. Arm spines 5 or 6 in a series; uppermost longest, somewhat flattened, wide basally but pointed at tip, about as long as an arm-segment; lower spines successively shorter, stouter and blunter, the lowest very blunt about twice as long as thick. When 6 spines are present, near base of arm, the series approximate quite closely on the dorsal side.

Oral shields diamond-shaped with rounded angles, longer than wide; madreporite largest and widest, its width little less than its length; the shields on either side of the madreporite are markedly longer than wide, while the remaining two are less conspicuously so. Adoral plates very large, meeting more or less evidently both radially and interradially. Oral papillae 2 on each side, flat and wing like, the outer distinctly larger than the inner.

Color of dry specimen: Inner portion of radial shields and many upper arm-plates, usually every second or third, deep gray or dusky, distal part of radial shields white, disk scales and many upper arm-plates whitish, often with minute dusky dots or markings. Arm-spines pale gray. Arms apparently banded with dusky especially distally where the contrast between white and dusky arm-plates is most marked. Orally white with distal portion of arms indistinctly banded with dusky.

Holotype, M. C. Z. no. 5009, from near Shell Islands, Darwin, N. T., 3–6 fms. July, 1929.

This very interesting little Ophiactis was taken with a number of *savignyi* and was not recognized at the time as being different. But when the specimens of *savignyi* from Darwin were being critically examined in Cambridge, it was at once evident that this specimen was not even nearly related to that species. The relatively huge radial shields are probably due to the disk being regenerated but the arm-plates and spines, the oral papillae and particularly the long oral shields and big adoral plates, combine to set this species quite apart from the species of Ophiactis hitherto known. It is of course unfortunate that the unique holotype is so extensively regenerating.

OPHIACTIS FUSCOLINEATA[1] sp. nov.

Disk 5 mm. in diameter. Arms 5, nearly or quite 40 mm. long. Disk covered by a coat of numerous scales, smallest near center and largest in the mid-interradii and around the rather large radial shields. The latter are each 1.25 mm. long and .50–.60 mm. wide; the 2 members of a pair are in contact distally but diverge considerably and are separated by several elongated disk scales. Most of the marginal scales bear slender spinules and a few disk scales do also. Upper arm-plates wider than long, quadrilateral, with distal margin slightly convex and much longer than the straight proximal side; lateral margins very oblique and outer corners much rounded; except at tip of arm, the upper arm-plates are broadly in contact.

Interbrachial areas below well covered with scales, many of which bear slender spinelets. Under arm-plates, broadly pentagonal, or if they are in contact, the proximal angle is more or less truncated, making them squarish; outer corners rounded and distal margin lightly concave. Side arm-plates not conspicuous. Arm-spines 5 in each series; at base of arm a sixth spine, smallest of all, may be present at the top of the series; ordinarily the 3 uppermost spines are longest and most slender, considerably exceeding a segment; the 2 lower spines are wider, slightly flattened and blunt, the lowest not much more than half as long as the one above it. Tentacle-scale single and large as usual in Ophiactis.

Oral shields rounded triangular, wider than long, the distal side more or less convex, inner sides lightly concave; madreporite much the largest, nearly elliptical. Adoral plates rather small, widely separated within but outer ends fully in contact radially. Oral papillae, single, rather scale-like but thick, truncate or rounded at tip, situated at junction of adoral and oral plates.

Color of dry specimen: disk pale gray, variegated with darker and spotted, notably on radial shields, with a still darker shade; spinules pale cream-color; upper arm-plates whitish variegated with dusky; some plates are entirely deep purplish-dusky; an ill-defined, broad, median line of purplish-gray runs the length of the arm, broadening out to occupy the whole width where the plates are wholly dark, restricted definitely to middle where plates are otherwise light; the dark upper arm-plates give the arms the appearance, to the unaided eye, of being regularly banded with a dark shade; arm-spines yellowish-white marked with dusky near base. Oral surface yellowish-white, with distal part of arms more nearly white but banded regularly with dusky; the bands are due of course to dark colored under arm-plates.

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[1] *fuscolineata* = with a dusky line, in reference to the characteristic marking on the arms.

Holotype, M. C. Z. no. 5047, from Broome, 5–8 fms., June, 1932.

This seems to be a common brittle-star on the northern coast of Australia as there are 35 paratypes from Broome, 28 from Darwin and Quail Island and 1 from Allaru Island, off Port Essington. Although superficially like *savignyi* and easily mistaken for it in the field, it is distinguished at once by the upper arm-plates and other structural details. To *modesta* also it bears some resemblance but on careful examination is found to differ in almost every feature. Apparently *fuscolineata*, unlike *savignyi* and *modesta*, has no 6-armed form and does not reproduce by autotomy. All of the present series, of all sizes, including very small ones, have 5 arms.

There is considerable diversity of color in this large series, depending chiefly on the amount of yellowish-white and the degree to which the yellow tint is present. The banding of the arms and the mid-dorsal line are naturally more striking in the case of light-colored specimens. Occasionally there is an individual with very little light color and then the dusky line and bands on the arm do not show up well.

The 65 specimens at hand are from the following places:

Northern Territory: Coburg Peninsula, Allaru Island, May 22, 1932. 1 specimen, young.
Darwin, June 13, 1929. 1 specimen, young. The first echinoderm we collected in Australia in 1929!
Darwin, East Point, June-July, 1929. 13 specimens, small adults and young.
Darwin, West Point, June, 1929. 7 specimens, small adults and young.
Quail Island, July, 1929. 7 specimens, young.
Western Australia: Broome, August-September, 1929. 7 specimens, small adults and young.
Broome, June, 1932. 29 specimens, adult and young.

OPHIACTIS LAEVIS[1] sp. nov.

Disk 5 mm. in diameter, bulging slightly in the interradii. Arms 5, moderately stout at base, attenuate distally, 15–20 mm. long. Disk covering a notably smooth coat of small irregular plates, rounded or with rounded angles, not overlapping but laid together like a pavement; there are apparently about 500 of these plates on the upper surface of disk; they are mostly about .20 mm. in diameter but a few are twice that size and many are much smaller. Radial shields very small, about half a millimeter long and a trifle more than half that in width; the two of a pair distinctly separated from each other except at the distal end. Upper arm-plates distally, fan-shaped with proximal angle more or less truncate and lateral angles rounded; proximally they are more and more in contact so that at base of arm they are nearly elliptical, about twice as wide as long, the proximal margin straight and shorter than the convex distal side.

Interbrachial areas below, closely covered with small scales, more inclined to overlap than on disk. Under arm-plates squarish with rounded corners, lateral margins a little concave, proximal and distal margins straight or convex. On many plates the proximal margin shows an angle pointing towards base of arm, so the plate is distinctly pentagonal; there is much individual diversity among the plates, some are wider than long, others are longer than wide; for the most part they are little or not at all in contact with each other. Side arm-plates rather small. Arm-spines usually 3 in a series, the middle one distinctly longest and exceeding the segments, the upper one more slender, the lowest, shortest and relatively stoutest; on basal segments of arm a fourth spine is present at the upper end of the series, but it is smaller than the one below it. Tentacle-scale single, relatively very large.

Oral shields diamond-shaped, a little wider than long; inner angle rather acute, lateral more rounded, distal more or less truncate; madreporite larger than the others, with length and breadth nearly equal. Adoral plates moderately large, nearly twice as long as wide, almost meeting both within the oral shield and radially but not actually in contact. Oral papilla single, very large and wing-shaped, occupying nearly the whole inner edge of the adoral plate to which it is attached; if closed down flat, the two in each mouth angle would overlap and close the whole angle, except close to the teeth.

Color of dry specimen, essentially the same as in life: disk purplish-rose color with half a dozen small and irregular patches of white; arms purplish-dusky, variegated with lighter shades; some isolated upper arm plates on basal half of arm nearly white and a very few reddish-brown; arm-spines on basal part of arm white, distally more or less dusky. Interbrachial areas below, rose-color becoming whiter proximally and quite white where they adjoin the mouth frame and basal part of the arms which are white. Under arm-plates beyond the first 2 or 3, become variegated with dusky (at first very faintly) and on distal part of arm, here and there, with reddish-brown.

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[1] *laevis* = smooth, in reference to the very smooth disk covering.

Holotype, M. C. Z. no. 5055, from Koombana Bay, Bunbury, W. A., 5–8 fms. October 26, 1929.

This handsome and unusual Ophiactis seems to be common in Koombana Bay, as we took 18 specimens during our morning's dredging. Professor Bennett has sent another which he took at Bunbury in January, 1930. That the species occurs along the Western Australian coast for a long distance is attested by 2 half grown specimens which Professor Bennett took at Dongarra. Unfortunately the striking rose color of the disk is not always present; one of the Dongarra specimens shows no trace of it but has the disk gray and white; one of the largest Bunbury specimens has the disk almost white in sharp contrast to the variegated arms, which show many traces of brownish-red; another large specimen has the disk gray and white; in many specimens the variegation of the disk with whitish is more marked than in the holotype; in one specimen the disk is prettily variegated with red, white and dusky. Aside from color, these specimens show little diversity though the radial shields are often larger and more conspicuous than in the holotype.

This is a very distinct species of Ophiactis, easily recognized, even when the rose color is wanting, by the disk covering and the remarkably large oral papillae. It is strange that Michaelsen and Hartmeyer seem to have taken no specimens in Koombana Bay, where they did some dredging, but they found one small specimen at Fremantle and a second still further north at Geraldton. Koehler (1907) found these two young individuals perplexing but finally identified them with *Ophiactis lütkeni* Marktanner-Turneretscher. He even borrowed the types of that species, 4 small specimens from Fernando-Po, and compared the Australian specimens with them. Unfortunately these types are all very small, and probably immature and Koehler's specimens of *laevis* were also only half-grown; the latter however showed the distinctive coloration, which permits of no doubt as to the species Koehler had in hand. He himself mentions the color as one of the three differences which he noted between his specimens and *lütkeni*, the others being in the scaling of the disk and in the surface of the upper arm-plates. He makes the curious suggestion that the finer disk-scaling in the African specimens might be because they were smaller than those from Australia, overlooking the fact that in ophiurans the disk scales increase in number and decrease (relatively) in size with growth. Comparison of young *laevis* from Bunbury with Marktanner-Turneretscher's photographs of *lütkeni* shows that the difference in the oral papillae is so great, it is hard to understand how Koehler could have made the identification he did.

OPHIODAPHNE MATERNA

KOEHLER, 1930. Vid. Med., 89, p. 129.

A perfect specimen of Ophiodaphne was dredged in 5–8 fms. of water near Broome, in June, 1932. As Mortensen's specimens from the Kei Island were taken at a depth of 245 meters, it seemed possible that the Broome specimen might represent a second species of this extraordinary genus. It is only 3 mm. across the disk and the arms are but 12 mm. long; the color is very light, an almost uniform brownish-white. Careful comparison with Koehler's figures and description shows so close an agreement that it hardly seems justifiable to base a second species on this single specimen. The only noteworthy difference is in the arm-spines, of which Koehler says there are four. The present specimen has 5 and sometimes 6 spines not only on some basal arm-joints but out beyond the middle of the arm. Koehler's photographs do not permit any accurate count of arm-spines, but they give the impression of more than 4 on many segments. Dr. Mortensen kindly reexamined the specimens in Copenhagen and found 5 arm-spines near base of arms. He then generously sent a paratype to the M. C. Z. It is 5 mm. across the disk and has a young one clinging closely to the oral side. No young individual was associated with the Broome specimen, as they generally were with Mortensen's, but of course a single instance proves nothing as to the habits of the Western Australian Ophiodaphne. The only notable difference between the two specimens before me is in the disk covering, which is perfectly smooth and flat, and composed of very small scales, in the one from Broome while the Kei Island specimen has the disk scales coarser and the disk surface rather rough. But this may well be only an age difference, for the Keian specimen is nearly twice as large as the Australian.

OPHIOTRICHIDAE

Ophiothrix acestra

H. L. Clark, 1909. Mem. Austr. Mus. **4**, p. 544.

A few typical specimens of this species are at hand. One was dredged in Port Jackson, off Middle Head, 4–6 fms., November 21, 1929 and is notable only for its fine color. The spinulation of disk (6 mm. across), the form of the upper arm-plates, the character of the arm-spines are all typical. The color is a deep dusky green, slightly variegated on the upper arm-plates and near the disk margin with whitish; the long disk spines are white or pale green; the arm-spines are glassy, tinged or margined with greenish or dusky.

A specimen collected among coral rock fragments at Shell Harbor, N. S. W., May 4, 1932, is a little larger (7 mm. across) than the Port Jackson specimen and darker colored; the disk dark brownish-dusky and all the spinelets and spines are tinted with purplish-brown rather than green; but on the upper arm-plates, which are longer and more rounded distally than is typical there is a distinct green tinge. Another large specimen from "between tides" at Shell Harbor, loaned by the Australian Museum, is notable for a distinct black line along the upper side of the arm, such as occurs in *O. stelligera* forma *atrolineata* (see p. 274). But in *acestra* the line does not become white near the tip of the arm.

The remaining specimens (7 young individuals) were collected by Mr. Melbourne Ward at Port Curtis, Queensland, and loaned by the Australian Museum. They have the disks 2.5 to 5.5 mm. across with the characteristic long, slender spines scattered thereon and the overlapping diamond-shaped or pentagonal upper arm-plates. They agree very well with each other in color but are very different from the New South Wales specimens as they have the disk gray or pale lavender-blue with the distal edges of the radial shields white and the long spines colorless or whitish. The upper arm-plates are variegated with purplish-red, gray of various tints and whitish; the arm-spines are glassy often tinged with purplish-red.

Ophiothrix caespitosa

Lyman, 1879. Bull. M. C. Z., **6**, p. 53.

This is a common Ophiothrix on the southern coasts of Australia and it is interesting to find that the range extends up the coast of Western Australia at least as far as Dongarra. Some years ago (1928, p. 430) I was in doubt whether *caespitosa* and *acestra* were really different forms, but the material in the present collection gives no difficulty. All of the *acestra* have slender disk spinelets and spines and the upper arm-plates, if not actually longer than broad have the distal margin conspicuously produced. In *caespitosa* on the other hand, the disk spinelets are thick and stumpy, often conspicuously so, the disk spines wanting or if present rather stout and thorny, and the upper arm-plates much wider than long, with the distal margin little or not at all produced.

There are 42 specimens of *caespitosa* at hand from the following localities chiefly in southwestern Australia:

New South Wales: Port Jackson, off Middle Head, 4–6 fms., November 21, 1929. 2 specimens, large adults.

Western Australia: Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 8 specimens, young. One is notable for a broad, blackish stripe running along the upper side of each arm, in sharp contrast to the general very light, nearly white, color. None of the other specimens show even a trace of a longitudinal stripe.

Bunbury, Koombana Bay, 5–8 fms., October 26, 1929. 13 specimens, small adults and young.

Rockingham, jetty piles, Feb. 9, 1932. E. W. Bennett leg. et don. 4 specimens, adult.

Fremantle, near Garden Island, 2–3 fms., October 14, 1929. 6 specimens, adults, very diverse in color and spinulation.

Rottnest Island, cove at northeastern end, October 19, 1929. 2 specimens, very young.

Dongarra. E. W. Bennett leg. et don. 7 specimens, adult and young. The adults are small and very light colored, almost white; they may have been bleached in preserving; in one the disk covering is typical, but in the other the thorny stumps are so low as to be almost little granules; under considerable magnification, it can be seen that they are short cylinders crowned with 4 or 5 perfectly erect delicate points around the margin.

OPHIOTHRIX EXIGUA

LYMAN, 1874. Bull. M. C. Z., 3, p. 236.

This little Ophiothrix seems to range over the whole coast line of tropical Australia. It is obviously a near relative of *caespitosa*, *acestra* and *stelligera* but the characteristic under arm-plates will always serve as a recognition mark. The radial shields are more completely covered, as a rule, than in its near relatives, and the absence of spines on the disk, the usual lack of a continuous stripe on the arm, the shape of the upper arm-plates, and the close approximation of the arm-spines dorsally at the base of the arm, are additional features which help to distinguish *exigua*. Nevertheless perplexing specimens occur and the possibility of hybridization — the last resort of the puzzled taxonomist — cannot be denied.

At Darwin, where we first met with *exigua*, its difference from *stelligera* was observed when the specimens were taken. My field notes say: "From sponges, near the Shell Islands, July 15. Disk closely covered (including radial shields) with low thorny stumps; pale violet blue. Upper arm-plates transversely diamond-shaped, the boundary of each more or less clearly outlined in white — at least the distal boundary, finely speckled with bluish. No longitudinal lines whatever." The violet coloration is often replaced by shades of pink or brown or even by cream-color; there is very great diversity. And there may be a longitudinal line on upper side of arm!

There are 101 specimens of *exigua* at hand taken at three widely separated points.

Queensland: Port Curtis, off Gatecomb Head, 9–12 fms. Ward and Boardman leg. 4 specimens.
Port Curtis. Melbourne Ward leg. 75 specimens. These two lots were loaned by the Australian Museum.
Northern Territory: Darwin, near Shell Islands, 3–6 fms., July, 1929. 14 specimens, adult and young.
Western Australia: Broome, June, 1932. 8 specimens, adult and young.

OPHIOTHRIX STELLIGERA

LYMAN, 1874. Bull. M. C. Z., 3, p. 237.

This is the common Ophiothrix of the tropical coasts of Australia ranging as far south as Bunbury[1] on the western side. It occurs in large numbers on suitable bottom in shallow water. It prefers a bottom covered with sponges, alcyonarians, ascidians, etc. and is particularly apt to be associated with sponges, the colors of which seem to have a notable effect on those of the ophiurans. It is the most diversified in color of any Australian brittle star and rarely are two specimens exactly alike. Vermilion red specimens are common and very noticeable — generally in association with red sponges. But under all conditions and regardless of other color features, *stelligera* always has a longitudinal line on the upper side of the arm. Typically this line is white, bounded on each side by a very narrow colored line. Often these colored lines become wider, coalesce and blot out the white, and thus the white line is replaced by a colored line, often bright yellow or vermilion red but not infrequently black. No matter however what the color of the line may be, if the arm is uninjured it will be discovered that at the growing tip of the arm the typical white line is present and the transition from white to color may be easily traced. This stripe on the upper side of the arm is the best specific character which *stelligera* possesses.

There is no doubt that *acestra*, *caespitosa* and *stelligera* are very much alike; the upper arm-plates of *caespitosa* are distinctive and the under arm-plates of *acestra* are different from those of *stelligera*. Nevertheless, these two last species would often be hard to distinguish were it not for *stelligera's* arm-stripe. There are two forms of *stelligera* that may for convenience be given names. Both occur at Broome and are by no means rare. They look so unlike that only careful examination, particularly of the growing tips of the arms, convinces one they are identical. In one, the ground color of the disk is a dull dusky purple; the arms are a similar shade but the upper arm-plates are somewhat variegated and the arms usually appear more or less distinctly banded; the stripe on the arm is white bounded by dark lines. This form may appropriately be called *atra* (Holotype M. C. Z. no. 5081); it occurs usually in very dark colored or purple-sponges. In the other form the disk and arms are usually very light, nearly white, but rarely gray, reddish or purplish; the stripe on the arm, except far out distally, is very dark, deep brown, dark purple, dark green, or black. This form may appropriately be called *atrolineata* (Holotype, M. C. Z., no. 5085).

The large series of *stelligera* at hand consists of 291 specimens from the following places.

More or less typical *stelligera*, 257 specimens.

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[1] Koehler (1907, p. 253) records it from Koombana Bay, at this point, but I cannot avoid the feeling that his material was really *caespitosa*.

Northern Territory: Darwin, dredged near jetty, 6–8 fms., July 4, 1929. 2 specimens, young.
Darwin, dredged near Shell Islands, 3–6 fms., July, 1929. 50 specimens, adult and young.
Darwin, dredged near Leper Station, May 25, 1932. 24 specimens, adult and young.
Western Australia: Cape Leveque, August, 1929. 15 specimens, adult and young.
Broome, August-September, 1929. 32 specimens, adult and young.
Broome, June, 1932. 125 specimens, adult and young.
Fremantle, City Beach, September, 1930. 1 specimen, adult. Loaned by Perth Museum.
Exact locality unknown. 7 specimens, young.

Forma *atra*, 20 specimens.

Western Australia: Broome, August-September, 1929. 5 specimens, adult.
Lagrange Bay, September, 1929. 7 specimens, adult.
Broome, June, 1932. 9 specimens, adult and young.

Forma *atrolineata*, 14 specimens.

Western Australia: Broome, August, 1929. 1 specimen, adult.
Broome, June, 1932. 12 specimens, adult and young.
Fremantle, Cottlesloe Beach, in a sponge. 1 specimen, adult. Loaned by Perth Museum.

LISSOPHIOTHRIX[1] gen. nov.

Disk covered with small well separated radial shields and numerous thin, rounded plates or scales among which the centrodorsal is easily seen; there are no granules, stumps or spinelets borne by these plates or on the radial shields. In the interradial areas at the margin of the disk and below are a few plates bearing relatively high slender bifid or trifid stumps. Under arm-plates, kidney-shaped. Upper arm-plates nearly as long as wide with a marked distal angle. Arm-spines very slender, blunt, sparsely but markedly thorny. Otherwise as in Ophiothrix.

Genotype, *Lissophiothrix delicata* sp. nov.

This is a monotypic genus of doubtful validity, but the contained species cannot properly be associated with the forms grouped in Ophiotrichoides, its entire facies and relationships are so wholly different. It is clearly most nearly related to *Ophiothrix exigua* with which it is found, and its status, in the light of its association with that species, will be discussed beyond after the description of the type species. It may be mentioned here that even the youngest specimens of Lissophiothrix show no hint of an Ophiopteron-stage. In this they are very different from Ophiotrichoides but resemble *Ophiothrix exigua*.

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[1] λισσός = *smooth* + Ophiothrix, in reference to the smooth disk.

LISSOPHIOTHRIX DELICATA[1] sp. nov.

Disk 5 mm. in diameter, arms rather more than 25 mm. long. Disk very flat and smooth, covered with rather numerous, thin, rounded scales among which a circular centrodorsal plate is evident; there are no spinelets or other outgrowths on the scales. Radial shields relatively small, much longer than wide, thin and smooth, the two well separated by several series of scales. In each interradial area, outside the disk scales are a number of scales, each of which carries a relatively long trifid stump or spinelet. Upper arm-plates pentagonal or rhomboidal with the proximal angle truncated, about as wide as long or a little wider; on the distal part of the arm they become longer than wide but they seem to remain in contact with each other to the very tip.

Interbrachial areas below covered with a thin naked skin but near the distal margin there are 15–20 minute scales, each carrying a relatively long slender trifid stump or spinelet. Under arm-plates kidney-shaped, much wider than long, the distal margin deeply concave, the proximal almost as markedly convex; near tip of arm, the plates become longer than wide but they are fully in contact throughout.

Arm-spines 6, very slender, very slightly curved, blunt, sparsely but conspicuously thorny, the third from top longest, more than twice the arm-width; they are longest on segments 8–20, quite short on segment 4 and earlier ones, gradually decreasing in length from segment 20 to tip of arm. The series on first two segments distal to radial shields approximate rather closely on dorsal side of arm. Tentacle-scale wanting on first arm-pore, small and scale-like on second, spiniform and rather conspicuous thereafter. Lowest arm-spine modified to form a relatively large comb with 4 long slender teeth, much like Koehler's figure (1922, pl. 98, fig. 4b) of the same spine in *Ophiothrix exigua*.

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[1] *delicatus* = delicate, in reference to the fragile character of this little species.

Oral shields somewhat pentagonal with corners rounded, very much wider than long; distal side short; proximal angle well-marked though blunt, proximal sides concave; madreporite, much the largest, with proximal angle wide and rounded. Adoral plates large, lying against the concave inner sides of the oral shield and nearly (or quite) meeting within; at the other end they are separated by the first under arm-plate but send a projecting angle down between the oral shield and the arm. Color of dry holotype, almost white; to the unaided eye it has a gray tinge; under the lens, there is a distinctly yellowish tinge on the central area of the disk. Other specimens from Broome are similar but in 2 there is a large dark bluish area at the center of the disk and several individuals are distinctly gray and white. Material from Darwin is, excepting one light colored specimen, definitely gray or green variegated or marked with white; in 2 or 3 cases a pair of longitudinal green lines run along the upper surface of the arm with a white stripe between; in other specimens indications of such line, more or less broken up at each joint, can be distinguished.

Holotype, M. C. Z. no. 5088, dredged at Broome, June, 1932.

This little Ophiothrix occurring both at Darwin and Broome is most perplexing. In everything except the disk covering, it is so similar to *Ophiothrix exigua* Lyman that were the disk covered with thorny stumps, the specimens would be referred to that species without a moment's hesitation. But the 34 specimens at hand have no thorny stumps and the scaling of the disk is so delicate and smooth it is beyond question that their absence is not artificial or accidental. Moreover the radial shields are narrower and more widely separated than in *exigua* and the arm-spines are slightly longer and more slender than in that brittle-star. Comparison with the large series of *exigua* at hand from tropical Australia, shows that these more or less obvious differences are not associated with age for young individuals of *exigua* with disks only 2 mm. across have the thorny stumps covering the whole dorsal side. Nor is there any notable individual diversity in the *exiguas* at hand in the density of the covering of stumps. On the other hand the specimens of *delicata* have the disk surface so perfectly smooth, it is hard to believe that such a feature has no significance. The possibility that the differences between the two forms may be due to sex deserves some consideration but there is no evidence at hand to justify the suspicion.

Like *exigua* and *stelligera*, *delicata* lives in and among sponges, or among rock fragments, bryozoa and corals, in shallow water (3-8 fms.). Unfortunately the exigencies of our crowded field work did not permit a critical study of the relation of *delicata* to the other two species in life but my field notes at Darwin say of this perplexing form: "Like Ophiothela, 5 rays, smooth disk. Green. An odd and very interesting species, many specimens but mostly very small — largest only 4 mm. across." Whether *exigua* was taken at the same time and place is not clear. It may be worthy of note however that among the 79 *exiguas* at hand from Port Curtis, Queensland, no *delicata* were found. At Broome, *delicata* was not taken in 1929, but in 1932 a number were dredged. None however were green as at Darwin. It is probable that this is due to the difference in the character of the bottom. The light color and considerably larger size of the Broome specimens makes an evident but unimportant difference in the appearance of the two lots. A single one of the specimens from Broome, slightly smaller than the holotype, has the thorny stumps of the interradial areas extending inward on to the disk but greatly reduced in size and sparsely distributed. This perplexing individual may easily be disposed of as either a hybrid or an extreme variant, but it throws no light on the status of the species.

The 34 specimens of *delicata* at hand are contained in the following lots:

Northern Territory: Darwin, near Shell Islands, 3–6 fms., July 24, 1929. 18 specimens, small and mostly young.
Western Australia: Broome, 5–8 fms., June, 1932. 16 specimens, chiefly adults.

MACROPHIOTHRIX[1] gen. nov.

Disk large, more or less soft and puffed in living specimens, flat in dry ones, with large, triangular radial shields arranged in conspicuous pairs; a more or less dense coat of low thorny stumps or granules covers the disk and part or all of the radial shields as well. Arms usually very long, at least 9–10 x disk diameter or more, even up to 20 x, (rarely in adults only 6–7 x), flattened, with upper arm-plates short and wide, broadly in contact. Arm-spines 6–9 in a series (at least on basal segments), flat, blunt or at least not acute, more or less finely thorny but not conspicuously so, the second or third from the top usually longest, about equal to width of arm or somewhat longer; as a rule the long arm-spines stand out horizontally, more or less at right angles to arm. Arm-spines of the first 4–6 arm-segments usually more or less reduced in size.

Genotype, *Ophiura longipeda* Lamarck.

For years the genus Ophiothrix has demanded subdivision but the difficulty of doing it properly is so obvious, the attempt has been steadfastly avoided hitherto. Now, however, faced with the task of identifying more than 25 Australian species, of which nearly half seemed to represent undescribed forms, I have been obliged to make a beginning. The long-armed species of the Indo-Pacific region are so obviously different from the European and American forms, it is easy to begin with them, and here is presented the result of that start based upon the Australian material at hand and the M. C. Z. collection. Lamarck's *Ophiura longipeda* is typical of the group and it is fortunate that Lyman (1865, p. 176) examined the type specimen and specifically mentions the angular form of the upper arm-plates, for this is one of its most important specific characters so that it is possible to distinguish *longipeda* with little difficulty today.

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[1] *μακρός* = *long* + Ophiothrix, in reference to the very long arms.

The described species which seem to belong to this proposed genus are as follows:

aspidota M. & T.
bedoti de Loriol
bellax Koeh.
belli Döderlein
expedita Koeh.
galateae Ltk.
hirsuta M. & T.
longipeda Lamarck
michaelseni Koeh.
obtusa Koeh.
punctolimbata von Mart.
rhabdota H. L. C.

I have never seen a specimen referred to *bedoti* and am unable to determine the distinctive characters of that species. Concerning the validity of some of the other species in this list particularly *punctolimbata* there is considerable question. Döderlein and Koehler have expressed doubts about von Marten's species but Matsumoto (1917, pp. 219, 226) has pointed out at least one distinctive feature so, until further study can be given to the group, 11 species may be accepted. Probably there are other species of Ophiothrix, in its present broad sense, which are congeneric with those listed above but I have made no effort to search them out. My only purpose is to set apart a group which is quite distinct from typical Ophiothrix and entitled to its own name. In addition to the 11 previously known species here included in the new genus, there are among the Australian brittle-stars at hand and in the M. C. Z. collection of Ophiothrix no fewer than 10 additional forms, which require names.

Macrophiothrix occurs everywhere along the tropical coasts of Australia and shows a most perplexing diversity. If the relationship of the various forms is to be made clear at all they must be designated and compared. The following artificial key to the 21 species here recognized, will serve to indicate their outstanding peculiarities and distinctive characters, but it must be borne in mind that *longipeda* is one of the largest of simple-armed ophiurans and its near relatives are also large. The growth changes therefore are very considerable. For example, the arms of *longipeda* grow to almost incredible length (over 600 mm.) under favorable conditions, yet of course in early youth are not notably long; specimens 5 mm. across the disk have arms only 30–40 mm. long and even when 15 mm. across, the arms are only about 10 x the disk diameter. The other characters such as disk-covering, shape of arm-plates and oral shields, number and appearance of arm-spines, are all subject to growth changes as well as to the usual individual diversity. It must be recognized therefore that the following key is planned to enable one to distinguish adult specimens, and individuals with the disk less than 10 mm. across cannot be certainly identified except by comparison with good series of specimens. Color pattern is more or less useful for "recognition-marks" but in some cases adults become dark colored and their markings obscure as they attain their full growth.

Key to Species of Macrophiothrix

A. Color red or reddish of some shade, sometimes very dark but never purple or bluish, with longitudinal white lines on both upper and lower side of arms.

Upper surface of arms with two dark lines between which is a white line and on either side a white line which is often broken up into irregular fragments . . . . *expedita*

Upper surface of arm with a single median white line . . . . *bellax*

A¹. Color gray, blue, lavender or purple, with or without more or less yellowish or white, the upper arm plates often spotted or marked with dark shades; occasionally some upper arm-plates are reddish in contrast to the usual purple or bluish.

B. Upper arm-plates smooth; occasionally in old individuals some may be roughly granular or prickly at the sides.

C. Oral shields large, nearly as long as wide, with spinelets of the interbrachial areas extending on to the distal portion.

D. Upper arm-plates perfectly flat, 3x as wide as long, with the sides almost completely rounded; proximal and distal margins straight and nearly equal; each plate has several (1–12) large, more or less circular very dark spots on the light blue-gray background . . . . *sticta*

D¹. Not as above.

E. Under arm-plates wider than long, with convex lateral margins, a straight or slightly concave distal margin and all corners rounded; tentacle-scale exceptionally large, rounded and scale-like . . . . *megapoma*

E¹. Not as above.

Arms and arm-spines very flat, the uppermost spine very small, flat and blunt, the following longer, then 2 or 3 long and horizontal, lowest 2 very small, more or less smooth and acicular; color light bluish-gray or lavender, with or without yellowish . . . . . . *spinifera*

Arms and arm-spines less flat, the uppermost and lowest less differentiated from the others; color of full grown adults very dark . . . . *scotia*

C¹. Oral shields with no spinelets on distal portion.

F. Under arm-plates with a broad more or less well defined longitudinal white stripe; in large specimens, this may be indistinct or wanting proximally but is evident distally, though it may be narrow.

G. Arms very short, 6–7 times disk diameter; disk covered with very low stumps and granules which also cover the radial shields sparsely but rather uniformly; color light gray (in a young specimen with a pinkish tinge), with a broad, not sharply defined white stripe on lower surface of arms and a narrow, more or less interrupted and incomplete line above . . . . *brevipeda*

G¹. Arms very long, 10x disk-diameter or more; disk covering and coloration not as above.

H. Mouth frames covered by a thick skin, so that the outlines of oral shields and adoral plates are more or less completely concealed; basal upper arm-plates hexagonal, not twice as wide as long, but in adults rapidly becoming much wider, with all angles somewhat rounded; a longitudinal white stripe bounded on each side by a dark purple line on upper side of arm . . . . *elongata*

H¹. Not as above.

Colors dark and light purple and brownish-yellow, a single distinct longitudinal light stripe on upper side of arm; large arm-spines rather long, tapering but blunt, not truncate and widened at tip . . . . *lampra*

Colors light purple or lavender and pale yellow or whitish; 3 more or less interrupted light stripes on arm, or none, except one distally; arm-spines rather short, truncate and widened at tip but not clavate . . *rhabdota*

F¹. No white stripe on lower surface of arms.

J. Upper arm-plates with distal lateral angles very sharp; proximal margin much shorter than distal, which is typically straight or concave, but often bending backward a little at each end; if distal margin is convex, the lateral angles of plate are nevertheless far distal to the middle of the plate; width of plate twice its length or more.

Disk covered with thorny stumps, and radial shields with coarse granules; arm-spines not clavate. . . . *longipeda*

Disk covered with rough spinelets and radial shields with a few scattered pointed granules or nearly bare; most of the large arm-spines strongly clavate. . . . . *belli*

J^1. Upper arm-plates not as above.

K. Upper arm-plates not very wide, width not twice the length, lateral angles rounded. Disk and radial shields rather uniformly covered with low thorny stumps; colors dull . . . . *obtusa*

K^1. Not as above.

L. Upper arm-plates more or less elliptical or tetragonal or hexagonal with strongly rounded corners.

Disk covered with low thorny stumps becoming granules on radial shields; arms often banded but not conspicuously so, frequently with a narrow longitudinal white stripe on upper surface of arms. . . . *hirsuta*

Disk covered with minute trifid thorns which extend over the radial shields as well, though less densely; arms very conspicuously banded with deep purple, but the bands may be incomplete (lacking on one side) and irregular . . . . *callizona*

L^1. Upper arm-plates with distinct lateral angles.

M. Each upper arm-plate with 3 white-spots along distal border . . . . *punctolimbata*

M^1. Upper arm-plates not so marked.

N. Arms short, only 7x diameter; radial shields rather uniformly covered (except at distal tip) by minute thorny stumps like those on disk. . . *calyptaspis*

N^1. Arms 10x disk diameter or more; radial shields more or less bare.

O. Under arm-plates with conspicuously thickened convex distal margins; tentacle-scales noticeably large; arm-spines not at all clavate . . . . *michaelseni*

O^1. Not as above.

Under arm-plates wide with distal margins concave. . . . . . *aspidota*

Under arm-plates with distal margin straight . . . . *galateae*

B¹. Upper arm-plates with the entire surface rough with minute prickly granules. . *rugosa*

It must of course be understood that the above key is merely a beginning. Repeated use will bring out its defects quickly. Several of the species are very unsatisfactorily known and at least 7 are based on only one or two specimens and hence nothing is known as to their diversity. No material whatever of *bellax* or *punctolimbata* is available to me and the specimens at hand of *aspidota* and *galateae* are not authenticated by any satisfactory authority. Nevertheless it has seemed best to include these species as well as may be in the key and let others with more abundant material correct my errors.

It will be noted that I have made no use of the minute characters of the disk spinelets or of the lowest arm-spine, to which Koehler gives no little weight. Frankly, I have not been able to see these microscopic details as Koehler did and so have been unable to make any use of them in my work. The thorny stumps may be roughly distinguished from thorny spinelets, the former being truncate with a crown of teeth or spinules, while the spinelets are more elongated, taper to a blunt, or less commonly an acute, tip and have teeth or spinules along their sides. Beyond this classification, it does not seem to me to be practicable to go. The thorny stumps intergrade on the one side with perfectly typical granules and on the other with the spinelets; apparently these changes are associated with an individual diversity due to unusually favorable, or unusually hard, environmental conditions. As regards the characters of the lowest arm-spine, I believe they are undergoing continual changes due to growth and resorption and the mechanical wear caused by the activity of the animal. Hence it is improbable that they furnish reliable specific characters. At any rate I have not yet found any that seemed to me trustworthy.

The best marked of the 21 species of Macrophiothrix included in the key, are undoubtedly *brevipeda*, *callizona*, *elongata*, *expedita*, *longipeda*, *megapoma*, *rugosa* and *sticta*. There is also little difficulty about *bellax*, though it is known from only a single specimen and that from an unknown locality; or about *hirsuta*, which has been reported again and again but constantly confused with *longipeda;* it is apparently a good species, though still with regrettably indefinite limits. The status of *belli* is debatable but it can be easily recognized as a rule. The 4 Western Australian species *calyptaspis*, *michaelseni*, *scotia* and *spinifera* are, with the exception of the first, known from an abundance of material and are probably quite distinct forms, but the 2 specimens upon which *calyptaspis* is based may be "freaks" and that species must be more extensively collected before its validity can be established. The new species, *lampra*, from Port Jackson and Long Reef also needs validation by more specimens. The remaining forms, *aspidota*, *galateae*, *obtusa*, *punctolimbata* and *rhabdota* are thoroughly unsatisfactory. It seems probable that *obtusa* is valid but the other 4 will very possibly prove to be synonyms of better known species.

The 21 forms will now be considered under 4 headings: (1) previously known species not in the Australian collections at hand; (2) previously known species in these Australian collections; (3) new forms not from Australia, here described for the first time; and (4) new Australian species. In each group the species are arranged alphabetically.

I. KNOWN SPECIES, NOT IN PRESENT COLLECTION

Macrophiothrix aspidota

Ophiothrix aspidota Müller and Troschel, 1842. Sys. Ast., p. 115.

This is to me the least satisfactory of all the forms included in the genus. The 4 specimens bearing the name *aspidota* in the M. C. Z. collection are all young and of doubtful identity. They show well the peculiar separation of the adoral plates which Koehler (1904, p. 88, 1922, p. 210) has emphasized, but unfortunately very similar adoral plates occur in various individuals of other species, and probably the character is not a reliable one. It is hoped that the publication of the above key will make it possible for some of my colleagues to define *aspidota* satisfactorily.

Macrophiothrix bellax

Ophiothrix bellax Koehler, 1922. Bull. 100 U. S. Nat. Mus., **5**, p. 211.

The unique holotype of this species is from an unknown locality. Its designation as a new species seems warranted.

Macrophiothrix expedita

Ophiothrix expedita Koehler, 1905. "Siboga." Oph. Litt., p. 96.

There are 2 specimens of this well-marked species in the M. C. Z. collection; 1 is a cotype from Sapeh Strait, D.E.I., 38 fms. and the other was taken by

Semper in the Pelew Islands and has been in the M. C. Z. for many years under the name *longipeda;* but a label in Mr. Lyman's handwriting bears a question mark, showing his doubt as to its being that species. It was long in alcohol and has lost nearly all the red out of its coloration but there is no doubt of its identity.

MACROPHIOTHRIX GALATEAE

Ophiothrix galateae LÜTKEN, 1872. Öv. Kongl. Danske Vid. Selsk. Forh. pp. 90 and 108.

The only specimen referred to this species which I have seen is one in the M. C. Z. collection taken by Semper in the Philippine Islands and labelled by Mr. Lyman "*Ophiothrix galateae?* Ltk." It looks to me very much like *hirsuta* but the upper arm-plates are as a rule more sharply angular. The disk with almost bare radial shields looks remarkably like Koehler's (1922, pl. 32, fig. 1) photograph of what he calls *aspidota* and the upper arm-plates are "very finely granulose" as Koehler describes them in *aspidota.* It seems probable that *galateae* is a synonym of *aspidota* although Koehler (1922 and 1930) treated them as quite distinct species and did not even compare them with each other.

MACROPHIOTHRIX HIRSUTA

Ophiothrix hirsuta MÜLLER and TROSCHEL, 1842. Sys. Ast. p. 111.

The identification of this species is not difficult in typical cases but there seem to be many individuals which approach *longipeda* on the one hand and *aspidota* on the other. None of the specimens of Macrophiothrix taken in Australia in 1929 or 1932 are to be referred to *hirsuta* and the specimen taken at the Murray Islands in 1913 and referred by me (1915, p. 272) to this species is not it. This individual is described beyond (p. 299) as a new species, *rugosa.* Koehler (1907, p. 252) refers to *hirsuta* 7 specimens taken by Michaelsen and Hartmeyer in 1905 in Shark Bay, W. A., and northeastward therefrom. One of these specimens is now in the M. C. Z. collection and I am describing it (p. 304) as a new species. It is utterly different from *hirsuta* from Zanzibar, which appear to be typical. Whether all of the Michaelsen and Hartmeyer specimens are like the one before me, it is impossible to say but it seems probable that *hirsuta* does not occur on the Australian coast.

Macrophiothrix obtusa

Ophiothrix obtusa Koehler, 1905. Siboga Oph. Litt., p. 98.

One of Koehler's cotypes from Madura Bay, Flores, D. E. I., 38–50 fms. is in the M. C. Z. collection. The relatively long upper arm-plates and the long, clavate second (or third) spine on each side arm-plate are quite distinctive. The dull unspotted and unstriped coloration may also be helpful in distinguishing the species.

Macrophiothrix punctolimbata

Ophiothrix punctolimbata von Martens, 1870. Arch. f. Naturg. **36**, p. 257.

Were it not for Matsumoto's (1917, pp. 219 and 226) account and figure of a distinctive coloration, it would be almost impossible to include this species in the present key, as I have never seen a specimen called *punctolimbata*. It should be noted that von Martens stresses the granular covering of the disk in contrast to the covering in *longipeda* and says nothing about white spots on the upper arm-plates. Moreover Matsumoto had but a single specimen upon which to base his figure and account. Obviously the species is most inadequately known.

Macrophiothrix rhabdota

Ophiothrix rhabdota H. L. Clark, 1915. Mem. M. C. Z., **25**, p. 278.

No specimens of Macrophiothrix which can be referred to this unsatisfactory species were taken either in 1929 or 1932. Besides the 7 specimens in the M. C. Z. from the Murray Islands, there is a long-armed Ophiothrix from Port Galera, Mindoro, Philippine Islands, collected by Professor L. E. Griffin, which I refer with much hesitation to this species. It is more uniformly violet than in the typical specimens, there are no stripes or other marks on the basal part of the arms but distally a narrow median line appears and far out near the very tips of the arms, a light line is more or less evident on each side of each upper arm-plate. On the oral surface the median white line is less well-defined and shows more tendency to be interrupted on the proximal part of the arm, than is typical; distally it is fairly well-defined but narrow. The disk-covering, the form of upper and under arm-plates, the arm-spines and the oral shields are all just as in typical *rhabdota*. It seems better therefore to call this specimen by that name than to attempt to distinguish it as a new species. It may well be regarded as an unusually violet *rhabdota*.

Koehler (1922, p. 230) has treated *rhabdota* as a variety of *expedita*, and there is some reason for so doing, but after comparing one of Koehler's types of *expedita* with the types of *rhabdota*, it does not seem to me they are so nearly related. I think the difference in color is a very important one and in addition to that, the upper arm-plates of *rhabdota* are shorter and wider than in Koehler's species and the arm-spines are also shorter and wider. Probably *rhabdota* is nearer to *longipeda* than to any other species.

II. KNOWN SPECIES IN THE PRESENT COLLECTIONS

Macrophiothrix belli

Ophiothrix belli Döderlein, 1896. Denk. Ges. Jena, **8**, p. 292.

This species, previously known only from the unique holotype taken at Thursday Island proves to be a common form at both Darwin and Broome. Moreover Captain Bardwell found it at Augustus Island, so it is probably distributed along the whole northern coast of Australia, wherever conditions are suitable. It is easily distinguished from *longipeda*, its nearest relative, by its conspicuously clavate arm-spines (one or more in each series), its disk-covering and its tendency towards bare radial shields. The clavate spines appear in quite young specimens but of course are not very marked until the disk is 8–10 mm. across. The radial shields tend to be bare, but are seldom free from all spinelets and usually have a good many; they are often spotted with dark purple. The disk covering consists of high thorny stumps more or less like spinelets, somewhat different from the low stumps of *longipeda*. The difference is not important but it is usually obvious. Since typical *longipeda* occurs at Darwin and Broome and even at Augustus Island, the question naturally arises "Are the two species really valid?" The only reply at present is "Adults can be easily distinguished." It will require further study on the northern coast to find whether the two forms actually occur together in the same habitat and to answer similar questions about them as living organisms.

In general *belli* is lighter colored and the arm-segments appear to be a little longer than in *longipeda*, the arm-spines seeming to be less crowded. This gives a somewhat different facies to *belli* and makes the species easy to distinguish from *longipeda* when specimens are placed together. But the specimens from Augustus Island, which are here referred to *belli* are notably darker than any others seen and the banding of the arms is very faint. The disks are dark brown, the arms violet or purple; in most specimens the arm-spines are more or less dull yellow; many are markedly clavate.

The 43 specimens of Macrophiothrix here referred to *belli* are from the following places:

Northern Territory: Coburg Peninsula; Port Essington and Allaru Island along shore. May 20-22, 1932, 4 specimens, adult and young.
Darwin, Casuarina Beach and Night Cliff, July, 1929. 7 specimens, adult and young.
Darwin, East Point, June and July, 1929. 5 specimens, adult and young.
Darwin, western side of harbor, July, 1929. 1 specimen, adult.
Quail Island, west of Darwin, July 7–9, 1929. 2 specimens, small adult and young.

Western Australia: Augustus Island, October, 1933. Captain B. E. Bardwell leg. 7 specimens, adult and young, unusually dark colored.
Broome, August and September, 1929. 9 specimens, adult and young; the largest have the disks 22–25 mm. across, the arms 300–340 mm. long.
Broome, June, 1932. 7 specimens, small adults and young.
Port Hedland, July 6, 1932. 1 very young specimen.

MACROPHIOTHRIX LONGIPEDA

Ophiura longipeda LAMARCK, 1816. Anim. s. Vert., **2**, p. 544.
Ophiothrix longipeda MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 113.

This species is not so common as *belli* apparently, on the northern and northwestern coasts of Australia, but it ranges far more widely in the tropics as a whole than does its near relative. Perfectly typical specimens of *longipeda* (as now understood) are in the M. C. Z. collection from Tahiti on the east to Mauritius and Zanzibar on the west; to the northward its range extends to Kominato, Japan, and to the southward to Port Curtis, Queensland. Koehler (1907) reports *longipeda* from Turtle Island, Port Hedland and the Abrolhos, in Western Australia, but as his knowledge of the species and its allies was greatly extended in later years, it is possible his identification of these specimens might have been changed. I have seen no specimens of *longipeda* from west of Broome, and south of North West Cape, I believe it is replaced by *michaelseni*. My own record of *longipeda* from South Africa (1923, p. 340) is probably erroneous for the small specimens are certainly not that species but seem to represent a hitherto undescribed form (See below, under *M. brevipeda*). There are 3 specimens labelled *longipeda* in the M. C. Z. said to be from the "east coast of South Africa, probably Delagoa Bay," and apparently the same form ranges to the coast of northern Natal (See H. L. Clark, 1923, p. 340). It must be emphasized however that these southern specimens are by no means typical as the arms are shorter than usual, the radial shields are small and perfectly bare and the upper arm-plates do not have as acute lateral angles as they should have. But unfortunately the material at hand is not adequate for describing a new species. Nevertheless it is very doubtful if *longipeda* occurs any further south on the African coast than it does on the Australian.

The 23 specimens of *longipeda* at hand from tropical Australia are not a typical series as the largest is only 18 mm. across the disk, scarcely half the size of full grown adults. It is notable that they come from the same places as *belli*, save for one specimen from Queensland, increasing the suspicion that *belli* and *longipeda* are not really distinct species—possibly the differences are associated with sex.

Queensland: Great Barrier Reef (near Mackay), Lindeman Island. Melbourne Ward leg. et don. 1 specimen, adult.

Northern Territory: Coburg Peninsula; Port Essington and Allaru Island, May 20–22, 1932. 2 specimens, small adult and young.

Darwin, Casuarina Beach, July, 1929. 2 specimens, small adults.

Darwin, East Point, June and July, 1929. 3 specimens, adult and young.

Darwin, dredged near Shell Islands and Leper Station. 6 specimens, young and very young.

Darwin, western side of harbor, June, 1929. 2 specimens, adult.

Western Australia: Augustus Island. October, 1933, Captain Beresford E. Bardwell leg. 1 specimen, young.
Broome, August and September, 1929. 3 specimens, small adults.
Broome, June, 1932. 3 specimens, young.

MACROPHIOTHRIX MICHAELSENI

Ophiothrix michaelseni KOEHLER, 1907a. Fauna Sudwest-Australiens, **1**, p. 250.

This species was not met with in our collecting but Professor Bennett has sent a Macrophiothrix taken by him at Bunkers Bay, W. A., in January, 1930, which seems to represent it. It lacks spines among the thorny stumps on the disk and there is no light line on the upper side of the arm but when compared with a specimen of *michaelseni* in the M. C. Z., from near Fremantle, the resemblances outweigh the differences. Obviously much more material of *michaelseni* must be collected and studied before the specific characters can be fully understood. The specimen at hand is about 15 mm. across the disk; the arms are all broken off, 45–85 mm. from the disk but they are flat and rather wide, with short wide upper arm-plates and flat, thorny, blunt but not clavate arm-spines; the arms are rather bright violet, very faintly and indefinitely banded; the arm-spines however are pale brown.

III. NEW SPECIES OF MACROPHIOTHRIX, NOT FROM AUSTRALIA

MACROPHIOTHRIX BREVIPEDA[1] sp. nov.

Disk rounded pentagonal, 12 mm. across, closely covered with granules or very low thorny stumps, which are obviously longer at the margin of the interbrachial areas; radial shields sparsely covered with granules, smallest and most sparse at the inner distal corner. Arms notably short, not more than 90 mm.; all are broken except one that is obviously regenerating. Upper arm-plates (fig. 20), 2.5–3x as wide as long, the lateral margins short and rounded, the proximal and distal margins more or less straight (often slightly convex or irregular) and broadly in contact.

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[1] *brevis* = short + *peda*, contrasting with *longipeda*, the type species, in reference to the unusually short arms for this genus.

Interbrachial areas below well covered with thorny stumps or granules. Under arm-plates (excepting the first 3 or 4) scarcely or not in contact, wider than long, oblong or somewhat pentagonal with an ill-defined proximal angle; all corners rounded; distal margin nearly or quite straight. Arm-spines 7, those on the first 5 segments, conspicuously reduced; on the following segments, the third or fourth spine from the top is longest, its length about equal to width of arm; it is flat, distinctly serrate along each margin, truncately blunt; the spines above and below are similar but shorter, the uppermost is often very short; lowest spine very small, smooth, sharp; the next similar but larger; the next much larger and blunter. Tentacle-scale small, thick and rounded.

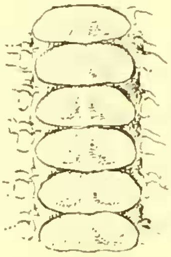

Fig. 20. Macrophiothrix brevipeda. Upper arm-plates. x 6.

Oral shields large, rounded pentagonal, with a fairly evident inner angle; about 1.5 mm. wide by 1.25 mm. long; madreporite largest, almost as long as wide. Adoral plates short and wide, lying on the proximal sides of the oral shield and meeting more or less evidently within; at the outer ends where they are widest, they are separated by the first under arm-plate. There are no spinelets on the oral shields. Color of dry holotype dull light gray; arm-spines nearly white; on the upper side of the arm distally is a median white line but proximally this becomes broken and appears only in fragments. Under side of arm brownish-gray with a broad, median white stripe, which is not sharply defined basally but becomes very distinct distally.

Holotype, M. C. Z. no. 4345, from Natal, off Umhlangakulu River, the mouth of which was N. W. by N., 7 miles, 50 fms. There is a much smaller paratype with disk about 7 mm. across from off the Itongagi River, Natal, in 25 fms. It is like the larger individual in most particulars but has a very slight pinkish tinge and the white line on the upper side of the arm is less distinct. The upper arm-plates are longer and not so wide and the proximal margin is much shorter than the distal one but the absence of lateral angles is just as evident.

These 2 specimens were collected by the "Pieter Faure" and were considered by me (1923, p. 340) "with little doubt" to be young *longipeda*. Wider acquaintance with the latter species convinces me that this is quite impossible, and there is no species with which it is likely they can be confused.

MACROPHIOTHRIX ELONGATA[1] sp. nov.

Plate 24, fig. 4

Disk 17 mm. in diameter nearly circular, somewhat puffed up and highest at center, covered as in *longipeda* with low thorny stumps which become mere granules on the radial shields. Arms 360 mm. long or more, thus nearly 21 times the disk diameter. Upper arm-plates more or less transverse-elliptical about twice as wide as long or a little wider, the lateral margins fully curved, the proximal and distal margins more or less nearly straight or the distal one somewhat concave; the proximal margin is the shorter; near the tip of the arms, the plates are longer and narrower; near the middle of the arms, the lateral margins are less perfectly rounded and the plates might be called rounded hexagonal rather than elliptical.

Interbrachial areas below well-covered with thorny stumps. Under arm-plates squarish with rounded angles, fully in contact; their outlines are obscured by the skin over them and made more difficult to determine by the variegated coloration; far out on the arm, the skin is thinner and the plates are then evidently longer than wide. Arm-spines on the first 7 or 8 arm-segments greatly reduced as in *longipeda;* beyond the disk, there are 7 or 6 (not often 8) on each side arm-plate; they resemble those of *longipeda* in being little thorny, somewhat flattened, blunt but not clavate; the uppermost is often very small and the lowest is always minute and sharp. Tentacle-scale small and inconspicuous, near base of arm it is pointed, distally it is rounded.

Oral shields large, imbedded in a thick skin which conceals their outlines, even in the dry specimen; this skin also completely conceals the adoral and first under arm-plates. There are no spinelets on or near the oral shields. Color of radial shields and disk plates deep bluish purple; the thorny stumps and granules and the margins of the radial shields all around, brownish-white; upper arm-plates light gray-violet; running the whole length of the arm is a narrow, median white stripe bounded on each side by a dark purple line; a few scattered dark purple spots may be found near the lateral margins of the plates; the margins themselves and the upper ends of the side arm-plates may be quite distinctly brownish-white. Arm-spines tinted with violet. Under arm-plates profusely variegated with purple and brownish-white; near the disk, the plates are light along the middle line, dark at margins, indicating the beginning of a median light stripe, but it is only on the distal half of the arm that this stripe is well marked; near the tip of the arm the stripe occupies the middle of the plates and their margins are also brownish-white, giving an appearance of 3 narrow, parallel stripes.

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[1] *elongatus* =stretched out, in reference to the unusually long arms.

Holotype, M.C.Z., no. 2361, from the Persian Gulf. F. W. Townsend leg. 1895.

There is an accompanying paratype from the same place and collector. It is much smaller, with the disk 10 mm. across, the arms 200 mm. long. The upper arm-plates are rounded hexagonal like those near the middle of the arm in the holotype. The under arm-plates can be distinguished; they are hexagonal with more or less rounded angles; near base of arms they are about as broad as long but distally they are distinctly longer than broad. The color is as in the holotype but the longitudinal lines both above and below are very distinct throughout the whole length of the arm. The oral shields and adoral plates are as completely concealed in this individual as in the larger one. This feature combined with the characters of the arm-plates and the striking coloration makes the recognition of *elongata* easy. Whether it is confined to the Persian Gulf or extends into the Arabian Sea remains to be discovered.

IV. NEW SPECIES OF MACROPHIOTHRIX FROM AUSTRALIA

Macrophiothrix callizona[1] sp. nov.

Plate 24, fig. 1

Disk 10 mm. in diameter nearly circular, flat, covered with minute trifid stumps, which extend over the radial shields quite uniformly but not as densely as elsewhere; while the stumps generally have but three sharp points, there are occasionally 4 or 5, and sometimes there are but 2 or only 1. Upper arm-plates transverse ellipses, with rounded ends and nearly straight, parallel, proximal and distal margins; the proximal margin is commonly somewhat shorter than the distal which is not rarely slightly concave; the plates are broadly in contact with each other.

[1] καλλίξωνος = *with beautiful girdles*, in reference to the handsome bands on the arms.

Interbrachial areas below with trifid stumps but chiefly near the distal margin. Under arm-plates (excepting the basal 3 or 4) squarish with rounded corners, commonly wider than long; distal border concave and plates evidently not in contact but separated by a transverse furrow. Arm-spines slender but blunt, very thorny, the third usually longest; uppermost often very small; 3 lowest very small, smooth. On the first 4 or 5 arm-segments, the spines are much reduced. Tentacle-scale very small, rounded.

Oral shields pentagonal, without spinelets, wider than long, all angles rounded, the innermost low and wide; madreporite conspicuously largest with a more evident proximal angle. Adoral plates small, about as wide as long, lying wholly on the proximal sides of the oral shields, separated radially by the first under arm-plate, barely meeting within.

Color of dry specimen, disk pale gray, conspicuously spotted with deep purple; radial shields variegated with gray and purple; trifid stumps brownish-white. Arms lavender-gray conspicuously banded with deep purple; arm-spines pale brown. The bands occur about every 3 segments; under a lens their boundaries are very indefinite; sometimes only half a band is formed, its fellow being not quite so far, or a little further, out on the arm; there are about 45 bands on the longest (the only entire) arm. Under arm-plates cream-color, speckled and occasionally blotched with deep purple.

Holotype, M. C. Z., no. 5112, from Broome, W. A. August, 1929.

Again at Broome in June, 1932, a somewhat smaller specimen of this lovely brittle-star was secured. It does not differ essentially from the holotype. The oral shields are lower and wider, more rounded diamond-shape than pentagonal. The coloration is a little more vivid as the light color on the arms is very pale and the arm-spines are nearly colorless. Apparently *callizona* is a very secretive species and is seldom dredged. Unfortunately its peculiarities were not noted in the field and the specimens were not distinguished from young *belli* until studied in Cambridge.

MACROPHIOTHRIX CALYPTASPIS[1] sp. nov.

Plate 25, fig. 3

Disk 10–11 mm. across, densely covered with low, thorny stumps which extend over the radial shields but not very considerably near their distal ends. Arms only 65–75 mm. long, fairly stout at base, with a moderately attenuate tip. Upper arm-plates 2–2.5 x as wide as long, broadly in contact; distal and proximal margins nearly straight, the former considerably longer; lateral margins with a distinct but rounded angle near the distal side.

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[1] καλυπτός = *covered* + ἀσπίς = *shield*,, in reference to the fact that the radial shields are well covered with thorny stumps.

Interbrachial areas below more or less naked except near the distal margin. Under arm-plates (excepting the first 3 or 4) wider than long, oblong with nearly straight margins and rounded corners, not in contact, but separated by distinct transverse furrows. Arm-spines 7 (6–8) not peculiar; uppermost often and lowest 2 or 3 always very small; frequently the uppermost spine is moderately long, the little spine which should lie above it being absent; some of the longer spines are thickened at the end and a few could be called capitate; all are blunt and more or less thorny. Tentacle-scale small, rounded or bluntly pointed.

Oral shields without spinelets, wider than long with all four angles rounded; madreporite largest, its length and breadth about equal. Adoral plates unusually irregular in size and form, just meeting within, as a rule, but widely separated radially; they are squarish or oblong, with all corners much rounded, the outer end normally wider than inner. Color of disk in dry specimens, gray with areas around radial shields somewhat yellowish; upper arm-plates gray-lilac and arm-spines brownish; an indistinct light line is visible along the upper side of the arm distally and there is a faint hint of "banding" on the arms, especially on the distal half. Mouth frame and basal under arm-plates cream-color but the arm-plates soon show a dusky tint especially near distal margin and distally whole plates, sometimes 2 or 3 together, are nearly black so that the outer half of the arm is distinctly banded.

Holotype, M. C. Z., no. 5114, from Broome, W. A. August, 1929.

There is a single paratype, also taken at Broome in August or September, 1929, which is of about the same size and proportions as the one described above. It is however much lighter colored but this is in part at least abnormal. The disk is quite yellowish as are 3 of the arms; the other two arms are gray lilac as in the holotype, but on only one are the blackish under arm-plates present; one of the yellowish arms becomes gray lilac at tip. The light colored median line on the upper side of the arms is more or less distinguishable but is very faint. The upper arm-plates have the distal margins slightly concave and the lateral margins are more rounded than in the holotype. My 1929 field notes throw no light on the habitat of these 2 specimens, but from the fact that we did not meet with the species in 1932 when nearly all collecting was done by dredging it seems probable that they were found under rocks on the rich collecting grounds at Entrance Point.

MACROPHIOTHRIX LAMPRA[1] sp. nov.

Disk 20 mm. across, pentagonal and flattened, 4 mm. thick. Radial shields large and conspicuous as they are noticeably bare, though each one carries a number of well spaced stump-like granules. Remainder of disk closely covered by low, thorny stumps. Arms 5, about 260 mm. long, stout at base, tapering gradually to a not very attenuate tip. Upper arm-plates (fig. 21) low, wide, with very sharp lateral angles as in *longipeda*; width of plate 2.5–3 x length; proximal margin straight, distal more or less convex.

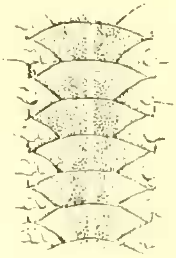

Fig. 21. Macrophiothrix lampra. Upper arm-plates. x 6.

Interbrachial areas below well covered with thorny stumps but they do not encroach on the oral shields. Under arm-plates (excepting first few) wider than long, oblong or somewhat hexagonal with all corners fully rounded; distal and proximal margins nearly straight, about equal, more or less completely in contact. Arm-spines 8 or 9, long, slender and bluntly pointed; the third from the top usually longest (4–5 mm.) much longer than width of arm itself. Uppermost spine may be very small; lowermost 2, small and smooth. The spines of the basal arm-joints are reduced as usual but the transition to the normal series is so gradual as to hide the contrast. Tentacle-scale large and scale-like, filling conspicuously the angle between the under arm-plate and the spine-bearing ridge on each side.

Oral shields very large, the madreporite largest; length and breadth about equal, triangular with angles rounded and often the distal side slightly projecting to connect with interbrachial area, but there are no spines or granules on the shield. Adoral plates rather large, rounded triangular or quadrangular with inner end much wider than outer, which lies between the oral shield and the arm-plates.

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[1] λαμπρός = *handsome*, of obvious significance.

Color of disk and upper arm-plates, in the dry specimen, deep purple with spots and markings which are nearly black; disk-stumps and arm-spines dusky, but basal part of arm-spines is violet; a light median line runs along the upper surface of arm becoming more and more white and sharply defined distally; many upper arm-plates (usually two together) are lighter than the others so that the arms are definitely, but not very conspicuously, banded with alternating areas of light and dark. On the lower surface, the mouth frame and oral shields are brownish-white and the distal portion of the arm-spines appears yellowish-brown in the mass. Under arm-plates dusky with a violet tinge, nearly black distally; a median whitish line runs the whole length of the arm; beginning at the fourth plate, the line is broad and distinct for half a dozen plates and then becomes broken into a more or less separate fragment on each plate, but distally becomes continuous again and runs to the arm-tip where it is very narrow.

Holotype, M. C. Z., no. 5116, from Bottle and Glass Rocks, Port Jackson, N. S. W. November 27, 1929.

On the day after the holotype was taken, 2 very fine paratypes of about the same size were collected at Long Reef, Colloroy, just north of Port Jackson. At the time they were supposed to be very large specimens of *Placophiothrix spongicola* (Stimpson) but in spite of a certain superficial resemblance, the differences are obvious when the two are side by side. It is not improbable that this superficial similarity has led to the confusion hitherto of these two quite unlike brittlestars.

MACROPHIOTHRIX MEGAPOMA[1] sp. nov.

Disk 18 mm. in diameter. Arms 5, very long but as all are broken at 100 mm. or less from the disk margin, one can only guess as to their relative length; it is very unlikely that they were less than 200 mm. long. Disk covered with thorny stumps of moderate height, longest near the interradial margins; these stumps more or less reduced to high granules cover the radial shields sparsely but rather uniformly. Upper arm-plates (fig. 22) low and wide, with a sharp lateral angle at the distal corners; the width is 2.5–3 x the length; the short proximal margin is straight while the longer distal margin is slightly convex.

Interbrachial areas below, rather densely covered with thorny stumps which pass into minute sharp spinelets on the posterior margin of the oral shields. Under arm-plates beyond the first half-dozen, wider than long, broadly in contact; lateral margins markedly convex, and distal and proximal margins nearly straight. Tentacle-scale wanting on first pore or two, small on the third and thereafter very large, scale like, rounded or truncate, rarely notched at tip. Arm-spines 7 (6–8) as usual, second or third from top longest, slender, tapering, not very thorny, bluntly pointed; uppermost often very small or wholly wanting; lowest minute and smooth.

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[1] *μέγας* = *big* + *πῶμα* = *lid*, in reference to the unusually large tentacle-scales.

Oral shields large, diamond-shaped, wider than long, with lateral angles rounded, distal angle even more rounded and proximal angle rather sharp, except on the very large madreporite. On all, the outer margin carries a number of minute spinelets, a few of which also occur on the face of the plate. Adoral plates rounded triangular, lying on the inner sides of the oral shield, just touching inwardly but widely separated radially; the pair adjoining the madreporite are greatly reduced. Color an almost uniform lavender-gray, the arm-spines somewhat transparent and hence lighter; upper arm-plates very faintly variegated with darker and on some plates especially at base of arm there are indications of a median white spot. Under arm-plates gray but white in the middle so there is a rather broad median white stripe along the lower side of the arm. Mouth frame and oral shields nearly white.

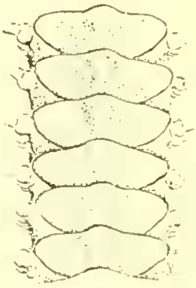

Fig. 22. Macrophiothrix megapoma. Upper arm-plates. x 6.

Holotype, British Museum no. 1936.6.2.1, from Penguin Channel, northern Queensland, 12–14 fms. Great Barrier Reef Expedition, "Magneta" St. IX. February 22, 1929.

This specimen was recorded by me (1932, p. 204) as *longipeda* but in the light of present knowledge, it is unquestionably a distinct species. There is in the M. C. Z. a paratype, taken by the "Challenger" near Cape York, St. 186, which was called *longipeda* by Mr. Lyman. This specimen was 23 mm. across the disk but the upper surface of the disk has been carefully removed and lies apart from the lower half; also the arms are all broken off close to the disk and only one fragment, less than 20 mm. long is present. Nevertheless the spiny oral shields and the very characteristic under arm-plates and tentacle-scales show beyond question its identity. Apparently *megapoma* occurs only on the northern Queensland coast.

MACROPHIOTHRIX RUGOSA[1] sp. nov.

Disk 16 mm. across, pentagonal, with concave radial sides, so that the interbrachial areas project. Arms 5, somewhat more than 165 mm. long, tapering rather uniformly from the base. Disk covered with thorny stumps, of which there are very few on the nearly naked radial shields and surprisingly few on the interbrachial lobes. Upper arm-plates (fig. 23), transverse-elliptical with rounded lateral margins; usually however the distal side is a little longer than the proximal and the plate is widest distal to the middle, so the ellipse is not symmetrical; the plates are 2–3 x as wide as long and broadly in contact; the entire surface is uniformly covered with minute prickly granules, making it noticeably rough to both sight and touch.

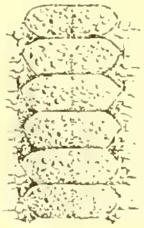

Fig. 23. Macrophiothrix rugosa. Upper arm-plates. x 6.

Interbrachial areas below nearly naked with only a few spinelets at the distal margin. Under arm-plates (excepting the first 3 or 4) oblong, wider than long, all four corners rounded, more or less fully in contact; the center is a little depressed and all the margins a little swollen; the whole surface is very minutely pebbled, like shagreen. Tentacle-scales small, somewhat larger distally; they are nearly triangular and fit rather snugly into the angle between the under arm-plates and the spine-bearing ridges. Arm-spines 6 or 7, rather slender, bluntly pointed, somewhat thorny; second or third longest but not much longer than width of arm; uppermost spines often very small, as the lowest always are.

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[1] *rugosus* = rough, in reference to the character of the upper arm-plates.

Oral shields without spinelets, rounded triangular about as long as wide, the distal side projecting but little; madreporite not very much bigger; all angles very much rounded, and proximal sides a little concave. Adoral plates more or less reduced and correspondingly irregular; they are rounded but not of uniform size or shape, and lie on the proximal sides of the oral shields, but are scarcely in actual contact with each other or with any other plates.

Color of dry specimen, nearly uniform purple on disk and arms, but the arms are rather conspicuously banded with alternating narrow areas of lighter and darker purple. Mouth frames and oral shields brownish-white tinged with or obscured by dusky. Lower surface of arms distinctly banded with alternating narrow areas, 1 or 2 plates wide, of light and dark dusky violet.

Holotype, M. C. Z., no. 3799, from Mer, Murray Islands, Torres Strait. October, 1913.

This unique brittle-star was recorded by me (1921, p. 110) as *hirsuta* but with openly expressed doubt as to the validity of the species. Now I believe the species is valid but this Murray Island specimen does not correspond with the present conception of *hirsuta*, and for the time being must be given a name for itself. Although references to forms of long-armed Ophiothrix with rough upper arm-plates may be found several times in the literature, they are indefinite and confusing. This is the only specimen I have ever seen which showed the character, although there is a specimen from Zanzibar in the M. C. Z., one of the types of Lyman's *cheneyi*, later considered *hirsuta* by Lyman (1882, p. 226) which has the lateral portions of several upper arm-plates distinctly rough in the same way. Possibly *rugosa* will prove to be only a variety of *hirsuta* but at present it seems to be quite a distinct form.

MACROPHIOTHRIX SCOTIA[1] sp. nov.

Plate **24**, fig. 2

Disk 23 mm. in diameter, arms 375–400 mm. long; although all the arms are broken, one is whole for enough of its length to make the calculation of approximate length, trustworthy. Disk covered with thorny stumps, somewhat longer and more slender than in *longipeda* but not essentially different. Radial shields more or less covered, though much less thickly than the disk itself, with smaller somewhat graniform stumps. Upper arm-plates low and wide, 2.5–3 x as wide as long, not flat but slightly arched, the distal margin longer and more convex than the proximal which is quite straight; lateral angles evident but somewhat rounded, more or less distal to middle of lateral margin.

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[1] σκότιος = *dark*, in reference to the color of adults.

Interbrachial areas below rather densely covered with thorny stumps distally, but near oral shields there are only a few well-spaced spinelets. Under arm-plates (except the basal ones) oblong, broadly in contact, wider than long with rounded angles, distal angles usually more considerably rounded than proximal. Arm-spines 8, the second or third from the top longest, slender, finely thorny, bluntly pointed, much longer than width of arm; uppermost spine often very small but distinctly spiniform, not at all flattened; lowest spine also spiniform and very small, the two above it distinctly longer and more thorny. The spines of the basal joints are reduced as usual but there is no very abrupt change beyond disk margin. Tentacle-scale low and inconspicuous until far out on arm it gradually becomes much larger and very conspicuous.

Oral shields large, rounded triangular about as wide as long or a little wider, the madreporite not strikingly different; distal margins with a considerable number of acute spinelets. Adoral plates ill-defined, rather large, but their outlines are concealed to some extent by thick skin; they are wholly proximal to the oral shields and seem to be in contact in the interradial midline. Color almost uniformly dark purple; upper surface darker and brighter than lower; indications of banding on the arms very faint; far out on the arm an indistinct light median line can be detected on the upper arm-plates.

Holotype, M. C. Z., no. 5118, from Entrance Point, Broome, W. A. August, 1929.

The very dark color of these large ophiurans was so different from the lighter shades of *belli* and *longipeda* that it seemed obvious that they were a different species but it was soon learned that the very dark shades are only assumed with full maturity. My field notes dated August 5, 1929, say: "Variable as usual but most specimens very dark; unfortunately some specimens were stained by antedonin in preparation. There is no red or reddish in life." August 15. "Huge one, blackest seen, brought up by diver. Some very dark at Entrance Point." The large specimens were of course easily distinguished from *belli* and *longipeda* but the smaller the specimens are the more difficult it is to distinguish the species. After careful comparison of all the young Macrophiothrix from northern Australia in the present collection, the following distinguishing features stand out.

In *belli*, the club-shaped arm-spines and the wider spacing of the series of arm-spines, combines with the light coloration to distinguish even quite young specimens. Young *longipeda* show quite early the characteristic angular upper arm-plates and this with the absence of club-shaped arm-spines makes their recognition fairly possible. Young *scotia* are much like *belli* but the spinelets on the oral shields are perfectly distinctive when they are present as they may be even in individuals only 5–6 mm. across the disk. When these spinelets have not yet appeared, the brightly colored, blue and white lower surface, and particularly a blue patch on each oral shield are helpful distinguishing features, but both *belli* and *longipeda* when very young may be exasperatingly similar. One feature of young *scotia* which has not been noted in either of the other species is the presence of spinelets among the thorny stumps of the disk. These are by no means always present but are sometimes numerous and conspicuous, and remind one of *michaelseni* of the west coast; they are not to be found after the disk is 10 mm. across.

The 47 specimens of *scotia* at hand are from the following localities. No adult specimens have been taken east of Cape Leveque yet the specimens here listed from the vicinity of Darwin have spinelets on the oral shields and are typical young individuals of *scotia*.

Northern Territory: Darwin, July, 1929, dredged. 1 specimen, young.
Darwin, Quail Island, July, 1929. 2 specimens, young.
Western Australia: Broome, Gantheaume and Entrance Points, under rocks, August and September, 1929. 14 adults.
Broome, September, 1929. 7 specimens, young.
Broome, dredged, June, 1932. 20 specimens, small adults and young.
Lagrange Bay, off False Cape Bossut, September, 1929. 3 specimens, young.

MACROPHIOTHRIX SPINIFERA[1] sp. nov.

Plate 24, fig. 3

Disk 20 mm. across, arms 275–300 mm. long; all the arms are broken, but one admits of giving an approximate measurement. Disk flat, rather thick, covered with a dense coat of very low, thorny stumps; radial shields almost as closely covered with thorny granules. Arms notably flat, the arm spines lying out horizontally on each side. Upper arm-plates, short, wide and nearly flat; width fully 3 x length; lateral margins with a rounded angle just anterior to the middle; both proximal and distal margins are straight and broadly in contact.

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[1] *spinifera* = bearing spines, in reference to the spinelets on the oral shields.

Interbrachial areas below densely covered with thorny stumps distally; proximally the stumps give way to spinelets which extend up onto the distal portion of the oral shields, where they are quite conspicuous. Under arm-plates (excepting the basal ones) as wide as long, or distinctly wider; they are not merely in contact but have the appearance of a slight overlapping; all angles are well rounded and the lateral margins are somewhat convex. Arm-spines 6–8, flat and blunt, very finely thorny, lying crowded together, quite horizontal; the uppermost spine in each series is very short, flat and blunt; the next is longer but much shorter than the 2 or 3 following which are notably long and flat; the lowest 2 are again very small. Tentacle-scales, large and scale-like becoming quite conspicuous on distal part of arm.

Oral shields very large somewhat wider than long, rather more pentagonal than rhomboidal, but with all angles even the innermost much rounded; madreporite not conspicuously largest; distal margins with many spinelets like those on the interbrachial areas. Adoral plates large, somewhat tetragonal with outer end wider than inner; they lie wholly proximal to the oral shield and meet quite fully in the interradial line. Color of dry specimen, light grayish lavender, the granules on the radial shields, the tips of the arm-spines, and particularly the distal ends of the radial shields more or less yellowish; mouth frame, oral shields and under arm-plates yellowish, cream-color or white; only on the distal portion of the arm, the under arm-plates gradually become violet and as the tip is approached are spotted with dark violet.

Holotype, M. C. Z., no. 5125, from Entrance Point, Broome, W. A., August, 1929.

In its fully adult condition this is a handsome and easily recognized Macrophiothrix but young individuals, with disks only 6–8 mm. across or less cannot be separated from young *scotia* with any certainty. As a rule the disk covering in young *spinifera* is made up of more minute and more widely spaced "thorny granules" than in *belli, longipeda* or *scotia* but some specimens whose disk-covering places them in *spinifera* have the blue blotches on the oral shields so characteristic of *scotia*. The adults of *scotia* and *spinifera* are so unlike it is certainly confusing to have the young ones so indistinguishable.

At Broome, *spinifera* is apparently fairly common but it was not distinguished from *longipeda* and *belli* until the dried specimens were studied. Apparently it does not occur either east or west of the Broome region for the 53 specimens at hand are all from that area.

Western Australia: Cape Leveque, August, 1929. 4 specimens a large adult and 3 young.
Broome, Entrance and Gantheaume Points, August and September, 1929. 11 specimens, large and small adults.
Broome, June, 1932. 37 specimens, adults and young, many of the latter of doubtful authenticity.
Lagrange Bay, September, 1929. 1 specimen, young.

MACROPHIOTHRIX STICTA[1] sp. nov.

Disk 15 mm. in diameter, rounded pentagonal not flat but rather convex, densely covered with very low thorny stumps, which become rough granules on the radial shields where they are numerous but by no means crowded. Arms all broken but the basal 90–100 mm. is present for two; they were probably at least 200 mm. long in life. Upper arm-plates (fig. 24), short and very wide (width about 3 x length), almost flat, elliptical but with the long distal and proximal margins very straight and broadly in contact; lateral margins more or less perfectly rounded, rarely with a hint of an angle just distal to middle.

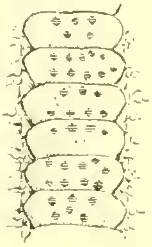

Fig. 24. Macrophiothrix sticta. Upper arm-plates. x 6.

Interbrachial areas below densely covered with thorny stumps which become acute spinelets near oral shields. Under arm-plates with outlines somewhat obscured by a thin skin; excepting the first 4 or 5 they are wider than long, oblong or somewhat hexagonal with all angles rounded; proximal and distal margins more or less nearly straight and in contact. Arm-spines 7 or 8, long, slender, delicate, very finely thorny, flattened particularly at the truncate or somewhat widened tip; uppermost acute, much shorter than the third and fourth, but not greatly reduced; longest spines greatly exceed the width of arm; lowest spine minute and very sharp. Tentacle-scale small, notably spiniform, but low and stout.

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[1] στικτός = *spotted*, in reference to the unusually spotted condition of the upper arm-plates.

Oral shields large with madreporite little larger than the others, which are wider than long, rounded pentagonal, or triangular with distal margin very convex; on that margin are a number of acute spinelets similar to those in the adjoining interbrachial areas. Adoral plates, rather large, oblong, but with outlines obscured by a thin skin; they lie wholly on the proximal side of the oral shields and are nearly in contact at their inner ends. Color of dry specimen, light lavender-gray, the arm-spines translucent near their tips; upper arm-plates with deep dusky almost blackish circular spots, ranging in number from 2 or 3 near distal margin, to 10–12, fairly well distributed over the whole surface of plate, excepting the lateral margins; around each of these spots the lavender-gray becomes pale, often nearly white and when there are many spots almost the whole of the surface of the plate approaches grayish-white. Under arm-plates grayish-white, prettily spotted and marked with deep blue-purple. Oral shields, light dull bluish.

Holotype, M. C. Z., no. 2345, from 6–8 fms., northwest of Middle Bluff, Shark Bay, Western Australia. Michaelsen and Hartmeyer leg., 1905.

This fine brittle-star was identified by Koehler as *Ophiothrix hirsuta* M. & T. and is so recorded by him (1907, p. 252), but the spiny oral shields, the unusually wide and flat upper arm-plates and the striking coloration show it is quite a different species probably most nearly related to *spinifera*. It was received by the M. C. Z. in an exchange with the Berlin Museum many years ago.

OPHIOTRICHOIDES MARTENSI AUSTRALIS

Ophiothrix martensi LYMAN, 1874. Bull. M. C. Z., **3**, p. 234.
Ophiothrix martensi australis H. L. CLARK, 1921. Ech. Torres Str., p. 111.

This is one of the commonest brittle-stars of tropical Australia, ranging from Port Curtis on the Queensland coast to Cossacks on the northwestern. It is very common at both Darwin and Broome and we also met with it at Cape Leveque. There seems no reason why it should not be placed in the genus Ophiotrichoides for the upper surface of the disk is perfectly smooth and free from spines and it is on that character that Ludwig (1882, p. 21) established the genus. The species selected for the genotype, *lymani*, has the interbrachial areas below completely naked but Ludwig does not refer to that fact in his generic diagnosis. In *martensi* and the following 3 species which are here placed in Ophiotrichoides, the interbrachial areas are more or less well covered with spinelets, but they are sometimes few and scattered and it seems best for the present not to separate the Australian forms from the tropical Atlantic species on that one character alone.

The series of *martensi* at hand is a very fine one and ranges from young ones less than 2 mm. across the disk to large adults 15 mm. in disk diameter. The smaller specimens are often light colored and the large ones may be very dark, but the pattern of coloration and the fundamental colors are remarkably constant. As Mortensen has pointed out (1932, p. 18), *martensi* is one of the species which passes through an Ophiopteron stage, and all our very young specimens show the "wings" admirably.

The 124 specimens at hand come from the following localities:

Queensland: Port Curtis. Melbourne Ward leg. 8 specimens, young. Loaned by the Australian Museum.
Great Barrier Reef, Lindeman Island. Melbourne Ward leg. 1934. 1 specimen, adult.

Northern Territory: Darwin, dredged near the Shell Islands, 3–6 fms. July, 1929. 71 specimens, mostly young and very young.
Darwin, May, 1932, near Leper Station. 18 specimens, young.

Western Australia: Cape Leveque, August, 1929. 1 specimen, large adult.
Broome, chiefly at Entrance and Gantheaume Points, August and September, 1929. 9 specimens, adult.
Broome, dredged at various points in or near Lagrange Bay, June, 1932. 16 specimens, adult and young.

OPHIOTRICHOIDES NEREIDINA

Ophiura nereidina LAMARCK, 1816. Anim. s. Vert., **2**, p. 544.
Ophiothrix nereidina MÜLLER and TROSCHEL, 1842. Sys. Ast., p. 115.

This is another well known species which belongs unquestionably in Ophiotrichoides, but the pattern of coloration and the shape of the arm-plates set it apart from the other members of the genus. Mortensen (1932, p. 17) has shown that it passes through an "Ophiopteron-stage" as do *martensi* and *smaragdina*. Perhaps the presence of this stage may be characteristic of Ophiotrichoides.

Apparently *nereidina* does not occur on the Australian coast west of Torres Strait. At any rate we did not meet with it. The only specimen at hand is a small adult from Lindeman Island, near Mackay, Queensland, sent in 1934 by Mr. Melbourne Ward.

Ophiotrichoides smaragdina

Ophiothrix smaragdina Studer, 1882. Abh. K.-Preus. Akad. Wiss. Berlin, p. 26.

This is perhaps the most beautiful, as it is one of the most distinctive, brittle-stars of the coast of northwestern Australia. Even in dry condition after many years, the beautiful green lines on the disk and upper and lower surfaces of the arms are very striking. In life the vividness of these lines, ranging in shade from "robin's-egg blue" to "emerald green," is even more pleasing, contrasting with the more or less nearly white background. At Darwin, *smaragdina* is quite common but at Broome it seems to be rare, for we did not meet with it in 1929 and in 1932 only secured one small specimen in Lagrange Bay. Yet the type locality is "off northwestern Australia." Moreover this Lagrange Bay specimen is very different from typical specimens in its remarkable coloration, which if it proves to be characteristic of Broome material would certainly warrant a varietal name. The upper side of the arm is green with a rather broad median line of yellow. In some Darwin specimens, the green tends to cover the upper arm-plates more or less and the median white line is cream-color and in one case quite yellow on the proximal part of the arm. Probably therefore the Lagrange Bay specimen represents an extreme instance of this increased pigmentation. The largest specimen of the Darwin series in only 9.5 mm. across the disk while the arms exceed 100 mm. All of the young individuals are in the "Ophioteron-stage," the web on the basal arm-spines being conspicuous. In very young specimens, the arms are only about 5 x the disk diameter but when the body is 4–5 mm. across the arms may be 15x that measurement!

The material at hand consists of the following 27 specimens:

Northern Territory: Darwin, near Shell Islands, 3–6 fms., on sponge and alcyonarian bottom, July, 1929. 25 specimens, mostly young; 1 is hexamerous.

Darwin, near jetty, 6–8 fms., mud and shell bottom, July 4, 1929. One small adult, very fine.

Western Australia: Lagrange Bay, 5–6 fms., June 24, 1932. One specimen, young and with unusual coloration.

Ophiotrichoides irregularis[1] sp. nov.

Disk 10 mm. across, arms 50–60 mm. long. Similar to *martensi* in all particulars except upper arm-plates and coloration. Upper arm-plates (fig. 25), irregularly tetragonal, pentagonal or hexagonal with all angles rounded, notably unequal in size and form, more or less in contact; distal margin longest, usually concave often markedly so, but may be straight or slightly convex; some plates are broken into 2 or 3 pieces, but others are marked with dark lines which give the appearance of a fracture, though it is doubtful whether a fracture really exists. Color of disk (dry) purplish-gray without markings; arms light gray, the arm-spines translucent; many upper arm-plates with no markings but many have a longitudinal whitish streak on one side or the other of the median line; rarely this light area occupies the whole median portion of the plate; proximally a very narrow black line runs longitudinally across various plates, generally not in the exact center, often looking like a fracture; distally this narrow black line becomes continuous and runs to the tip of the arm. Lower surface of arms dusky-gray with a broad ill-defined, median, whitish stripe running the whole length of the arm; often the lateral margins of the under arm-plates also tend to be whitish.

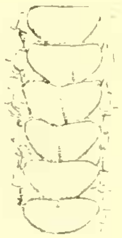

Fig. 25. Ophiotrichoides irregularis. Upper arm-plates. x 6.

Holotype, Australian Museum no. J 6042, from Port Curtis, Queensland. Melbourne Ward leg. Loaned by Australian Museum.

This is a perplexing specimen, obviously related to *martensi* but so different from any of the hundreds of specimens of that species which I have seen, it seems unwise to call it even a variety of that handsome species. It is conceivable that it is a "freak," with unusually irregular upper arm-plates, which has become bleached since it was collected, but it doesn't look that way and I am inclined to the belief that it will prove to represent a valid coastal species of Queensland. At any rate, it is desirable to call attention to it by giving it a name.

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[1] *irregularis* = not according to established standards, in reference to the character of the upper arm-plates.

OPHIOTRICHOIDES PULCHRA[1] sp. nov.

Disk 8 mm. across, arms 55–60 mm. long. So similar to *martensi* that were the coloration the same, there is no doubt it would be referred to that species. The scaling of the disk is however finer and noticeably smoother than in the related species. The oral shields are also different as the length nearly equals the width, the outline being rounded rhomboidal; the madreporite is oval.

Color in life uniform, bright yellowish-orange, above and below, without markings of any kind. The preserved specimen is yellowish with a hint of orange around the disk margin but fading out to white at the arm tip; on one arm very near the tip a very narrow dusky median line is visible.

Holotype, M. C. Z., no. 5142, from Entrance Point, Broome, W. A. June, 4, 1932. Frances L. S. Clark leg.

This brilliantly handsome brittle-star was found by Mrs. Clark on the under side of a rock fragment near low water mark, but nothing like it was seen before or afterwards. The entire absence of any markings distinguish it at once from the other members of the genus.

PLACOPHIOTHRIX[2] gen. nov.

Similar to Ophiotrichoides but some at least of the relatively few and coarse disk scales bear spines, spinelets or thorny stumps or high granules. Radial shields large and perfectly bare. Arms short or of moderate length, 5–9 times disk diameter.

Genotype, *Ophiothrix melanosticta* Grube.

This is an easily recognized group standing between Macrophiothrix and Ophiotrichoides. It can be distinguished from the former by its very smooth, sharply defined radial shields and the fact that the spines or spinelets on the disk are ordinarily well-spaced and sometimes few and low. From Ophiotrichoides it differs in the presence of spines or spinelets on some of the disk scales and even when these are low and scattered the general facies is distinctive. No attempt has been made to determine how many species of Ophiothrix now known belong in the group, but there are in the present collection 6 previously known forms and 2 which seem to be undescribed that are included here in Placophiothrix.

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[1] *pulcher* = beautiful, in reference to the striking coloration.

[2] πλάξ = *a plate* + Ophiothrix, in reference to the big bare radial shields.

PLACOPHIOTHRIX ARISTULATA

Ophiothrix aristulata LYMAN, 1879. Bull. M. C. Z., **6**, p. 50.

There is a single badly damaged but typical specimen at hand loaned by the Australian Museum. It consists of the body with one arm attached and 2 detached arms. The disk is 10 mm. across. It was taken in a trawl in 120 fms., 22 miles east of the Port Jackson heads, by Captain K. Moller. The "Endeavour" met with *aristulata* repeatedly in water over 65 fms. deep around Tasmania and southeastern Australia. The specimens recorded by me (1928, p. 430) from "Palmerston, N. T.," probably were not taken there, for the species is known only from water exceeding 50 fms. in depth and there is no water anywhere nearly so deep near Port Darwin (Palmerston). It is doubtful whether *aristulata* is really a Placophiothrix but until the genus is more sharply defined the species may rest here.

PLACOPHIOTHRIX LINEOCAERULEA

Ophiothrix lineocaerulea H. L. CLARK, 1928. Rec. S. Austr. Mus., **3**, p. 432.

This species was described from a single specimen in the South Australian Museum, from an unknown locality. It was therefore a very pleasant surprise to discover it at Broome in 1929 and soon to learn that it is one of the handsomest and most characteristic brittle-stars of that region. We dredged it repeatedly in both 1929 and 1932 as far to the southwest as Lagrange Bay, but we did not find it at Cape Leveque nor east thereof. It was not met with on the western or southern coasts of Australia, so it is almost certain that the type in the South Australian Museum must have come from the northwestern coast.

The series at hand is made up of 100 specimens ranging in size from 2.5 to 20 mm. across the disk. The arms are usually 7–8 times the disk diameter but in a few individuals are shorter. The color is remarkably constant, particularly as concerns the blue lines on disk and arms, but there is great diversity in the amount of blue on the lower side. In many individuals, the oral shields, adoral plates and under arm-plates are white or cream-color with a tinge of blue in some cases, and blue spots or blotches of very irregular size and distribution. In young individuals the ground color of the whole animal is white and the blue is a very bright blue, but with growth the white may become cream-color, yellowish or brown and the blue, bluish-dusky. The arm-spines are often brown of some shade, ranging from light wood-brown to a real rusty brown.

A most interesting point is that the very young specimens, with disks less than 5 mm. across, and some a little larger, are in a marked "Ophiopteron-stage," the webbing on the spines often conspicuous and quite stout. The relationship to *striolata* is thus emphasized but the differences between the 2 species are conspicuous.

Except for one small specimen taken in Lagrange Bay in 1929, all of our *lineocaerulea* were taken under rocks along shore at Entrance and Gantheaume Points or near the jetty at Broome, or were dredged between Broome and False Cape Bossut.

PLACOPHIOTHRIX MELANOSTICTA

Plate **12**, figs. 3–5

Ophiothrix melanosticta GRUBE, 1868. Jahrb. Schles. ges. Vaterl. Cult., **45**, p. 45.

This beautiful brittle-star is certainly one of the features of the marine life in shallow water in Roebuck Bay. Its abundance and diversity of color combine with its interesting habits to make it a source of continual surprise and pleasure. At Darwin on the other hand, we met with but a single specimen and that one, very young, only 3.75 mm. across the disk. It was dredged in 3–5 fms. on the west side of Port Darwin near Three-and-a-half mile Reef, on "dead" bottom. The beautiful red and green colors, with the sharply defined dark spots, were very striking. My field notes say: "Red and green shades delicate and evanescent. In preservation and drying the green color is nearly lost and becomes olivaceous while the delicate rose-red becomes distinctly orange." Finally the red shades disappeared altogether.

The first specimens taken at Broome were dredged in 4–8 fms. in Roebuck Bay, a mile or two southwest of the jetty. They were associated with comatulids, particularly Zygometra, and in some cases were apparently commensal, being as closely attached to the crinoid as is Ophiomaza. The extreme tides of early September made it possible to walk about on this bottom where a few weeks before we were dredging in 5 fms. and it was then possible to study more satisfactorily the relations of its inhabitants to each other. The bottom was a firm muddy sand and sparsely scattered over it were individual plants of a calcareous alga. These plants were frequented by both comatulids and brittle-stars, particularly by *Zygometra comata* and *Placophiothrix melanosticta.* It soon became evident that the brittle-stars ordinarily merely sought shelter beneath the crinoids but often, especially with individuals of the larger species of Zygometra, they attached themselves very closely and firmly to the crinoid. In a few cases, the attachment was so intimate and the mouth of the ophiuran was so related to the oral disk of the comatulid, it was natural to assume that the relationship was a continuous one and caused by the quest for food and not merely for shelter.

Aside from its interesting habits, *melanosticta* is notable for its surprising diversity of color. When very young (disk diameter less than 5 mm.) the ground color is ivory white with the interradial portions of the disk and 8–10 narrow bands on the arm light green; on each radial shield and every third or fourth upper arm-plate is a small sharply defined dark spot. With growth these spots become more numerous, larger, darker and more sharply defined, until they are quite the distinguishing color character of the species; but in full grown specimens (15–20 mm. across the disk) the general pigmentation may have become so heavy that these spots are obscured or even wholly indistinguishable. After the brittle-star is 4–5 mm. across the disk, the inner ends of the radial shields and the hitherto white portions of the arms take on a rosy red tinge (Pl. 12, fig. 5). With growth the red and green shades become more and more pronounced and the white disappears. Dusky shades appear and the animal becomes darker as well as more and more variegated with red and green and the black spots. Many large adults show and apparently retain throughout life this handsome coloration (Pl. 12, fig. 3), but others follow one of two quite different lines of development, resulting in adult individuals so unlike the typical form and so unlike each other that were it not for plentiful connecting links three "species" might be recognized.

Along one line development is associated with increased pigmentation and the extreme is reached in uniformly black individuals; as dried specimens, these are a very deep red-purple; before the extreme is reached the distal portion of the arm is more or less irregularly marked or even banded with white. The other line of development seems to be caused by deficient pigmentation; the red and green shades disappear; except for black spots and lines, the animal becomes milk white; the black is never wholly lost and usually persists in broad longitudinal lines on the disk and on the upper or under side of the arms; in extreme cases these lines are broken up into irregular fragments of greater or less prominence (Pl. 12, fig. 4). In preserved specimens, the white becomes yellow or even buff, very different from the appearance in life. Aside from the young individual taken at Darwin, the 65 specimens of *melanosticta* at hand were all taken in Roebuck Bay or in that vicinity. Koehler (1907, p. 253) reports a specimen from Port Hedland and that is apparently the western limit of the species, so far as now known. The largest specimens have the disk 15–18 mm. across (in their present condition) and the arms 125–150 mm. long. Some individuals have the arms more attenuate than others. In very young individuals, less than 4 mm. across the disk, the basal arm-spines are incompletely webbed, indicating that an Ophiopteron stage is passed through when the young ophiuran is only 2–3 mm. across the disk.

PLACOPHIOTHRIX PLANA

Ophiothrix plana LYMAN, 1874. Bull. M. C. Z., **3**, p. 238.

This little brittle-star occurs in large numbers on the northern coast of Australia. It was particularly common near the Shell Islands at Darwin and at Entrance and Gantheaume Points, Broome. But the largest and finest specimens were collected at Cape Leveque where several individuals 6–7 mm. across the disk, with arms about 40 mm. long, were taken. The diversity of color is very great but light gray, gray-brown or gray-purple is the usual ground color; this is more or less variegated with whitish and finely speckled with black. Some individuals appear yellowish or light brown and one adult specimen is red-purple. Whether *plana* is really congeneric with *melanosticta* is open to question, and the doubt is strengthened by the fact that there is no trace of an Ophiopteron-stage, even in the smallest specimens.

The 111 specimens at hand are from the following places:

Northern Territory: Darwin, near Shell Islands, 3–6 fms., July, 1929. 27 specimens.
Quail Island, July, 1929. 1 specimen.
Western Australia: Cape Leveque, August, 1929. 7 specimens.
Broome, Entrance and Gantheaume Points, August and September, 1929. 45 specimens, adult and young.
Broome, 5–8 fms., June, 1932. 31 specimens, adult and young.

Placophiothrix spongicola

Ophiothrix spongicola Stimpson, 1855. Proc. Acad. Nat. Sci. Philadelphia, **7**, p. 385.

This is one of the characteristic echinoderms of the southern coast of Australia; on the east it ranges as far north as Broken Bay, N. S. W. and on the west to Dongarra, W. A. and the Abrolhos Islands. It is a handsome species with its red and blue coloration and grows to a fairly large size, up to about 20 mm. across the disk. Although the spinelets on the disk are never long and conspicuous and in old individuals are reduced to mere knobs, the species is best treated as a Placophiothrix. Very small individuals with disk less than 5 mm. across usually have no disk spines, except minute ones at the interradial margins and they might be assigned to Lissophiothrix or even to Ophiotrichoides. Such young specimens usually show little or no red in their coloration (at least in preserved material) but are white prettily marked with blue and look very unlike the heavily pigmented adults.

The 27 specimens of *spongicola* at hand are from the following places:

New South Wales: Colloroy, Long Reef, November 28, 1929. 2 specimens.
Port Jackson, Bottle and Glass Rocks, November 27, 1929. 1 specimen.
Shell Harbor, May 4, 1932. 5 specimens, adult and young.
Western Australia: Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 12 specimens, adult and young.
Bunbury, October 25, 1929. 1 specimen.
Point Peron, October 11, 1929. 1 specimen, large adult.
Freemantle, near Garden Island, October 14, 1929. 1 specimen, small adult.
Rottnest Island, western end. Drummond and Swan leg., 1930. 1 specimen, small adult.
Dongarra, February 4, 1931. E. W. Bennett leg. et don. 3 specimens, young.

Placophiothrix striolata

Ophiothrix striolata Grube, 1868. Jahrsb. Schles. ges. Vaterl. Cultur, **45**, p. 45.

Mr. Ward has sent a single small specimen of this handsome East Indian species from Lindeman Island, near Mackay, Queensland, which is the furthest south, that *striolata* has been recorded on the eastern coast. Koehler (1907,

p. 253) has reported 2 small specimens from near Fremantle on the western coast, but it is more than probable that these were young *spongicola*. The two species when not more than 7 mm. across the disk are surprisingly alike. Aside from this record of Koehler's, *striolata* has not been met with west of Torres Strait.

PLACOPHIOTHRIX TRILINEATA

Ophiothrix trilineata LUTKEN, 1869. Add. ad Hist. Oph., pt. 3, p. 58.

It was most surprising to find at Lord Howe Island this very handsome brittle-star, which I first met with in 1913 at Mer, in the Torres Strait region. It has not been taken hitherto on the eastern side of Australia south of lat. 11°. It does not seem to be very common at Lord Howe as we only secured 4 specimens. These were found among the corals at Neds Beach and are typical adults.

Among the brittle-stars loaned by the Australian Museum is a small Placophiothrix, scarcely 5 mm. across the disk, from Batt Reef, Queensland, taken by A. R. McCulloch in 1918. The specimen is in poor condition and the coloration is deep blue and white, without a hint of the green usually seen in *trilineata*, but there is little doubt that it is a representative of that species. It is naturally of special interest as the first record of *trilineata* from the mainland coast of Australia.

PLACOPHIOTHRIX ALBOLINEATA[1] sp. nov.

Disk 11 mm. in diameter, with rather conspicuous lobes in the interradii. Arms about 85 mm. long, with rather attenuate distal half. Disk covered with the large, smooth triangular radial shields and rather numerous small, thick, rounded scales; those near the center of the disk are more or less circular, those between and beside the radial shields are usually longer than wide, often conspicuously so; on each of the scales on the central area is a short, slender, somewhat rough spinelet but its length hardly exceeds the diameter of the scale which bears it; a few of the scales between the radial shields and some on the interradial areas (many, close to the disk margin) carry similar spinelets. Upper arm-plates (fig. 26) much wider than long, with sharp lateral angles; some are quadrilateral with a convex distal margin, a much shorter, straight, proximal margin and straight, oblique sides, the lateral angle markedly distal to horizontal middle of plate; others are more hexagonal, the lateral angles near the middle of the plates and the distal margin made up of a short straight distal side and two oblique sides connecting it with the lateral angles; most of the plates are intermediate between these two extremes.

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[1] *albus* = white + *linea* = a line, in reference to the conspicuous longitudinal white line on the upper side of the arms.

Interbrachial areas below covered by very thin plates, appearing almost naked; only a few bear spinelets and these are near the distal margin. Under arm-plates more or less elliptical or even circular, with a straight proximal margin, where they are broadly in contact; the width and length are nearly equal but at the very base of the arm and far out distally the length is distinctly greater. Arm-spines 7 (or 6) the third (or second) from the top, longest, the 2 lowest minute and spiniform; the longer ones are slender, a little flattened slightly curved, blunt or truncate, and more or less thorny. Tentacle-scales spiniform but small and stout; distally they become larger and more scale-like.

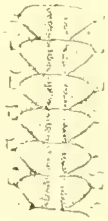

Fig. 26. Placophiothrix albolineata. Upper arm-plates. x 6.

Oral shields moderately large, the madreporite largest; excepting the madreporite the shields are rhomboidal, distinctly wider than long, the lateral angles rounded, the proximal wide but not rounded, the distal rather sharply acute. Adoral plates moderately large, narrower within where they nearly or quite meet, than without where they are widely separated by the first under arm-plate.

Color of dry specimen, gray-violet, the disk scales, more brownish; there are touches of dark violet or blackish on the margins of the radial shields; the arm-spines are translucent violet, the upper ones more or less dusky near tip. On the upper side of each arm, running the entire length from base to tip is a conspicuous white line, rather sharply delimited by a narrow dark line on each side; on the basal plates the white line is about one-third the width of each plate but it becomes narrower steadily and is very narrow at tip of arm. Oral frame, oral shields and basal under arm-plates yellowish-white; sides of under arm-plates beyond disk, dusky gray, but central portion occupied by a white area which forms part of a very broad and conspicuous white stripe running the length of the arm; on some plates on the basal part of the arm the white expands to occupy nearly or all of the surface of the plate; elsewhere, especially near middle of arm and distally, the gray of the lateral parts of each plate is noticeably darker and tends to form a narrow dark line delimiting the white stripe.

Holotype, M. C. Z. no. 5174, from a head of living coral at Neds Beach, Lord Howe Island. April 22, 1932.

This unique specimen was collected in the same habitat with *P. trilineata* but was not actually in the same coral colony, in which specimens of that species were found. It is apparently more nearly related to *spongicola* than to *trilineata* but is markedly different from the Port Jackson brittle-star in many features. It is very unlike any Ophiothrix I have ever seen except *O. hybrida* H. L. Clark (1915, p. 272) to which the upper arm-plates and color of arms show a notable resemblance. But the disk covering in the two species is so different they can hardly be conspecific. There is none of the many species of Ophiothrix named by Koehler that corresponds at all closely with it. Its apparent rarity at Lord Howe is probably due to the fact that its normal habitat is considerably below low water mark and few individuals wander into that zone near the tide line which is accessible to the collector. We cannot even guess how many such species there may be!

Ophiopteron elegans

Ludwig, 1888a. Zeit. f.w. Zool., **47**, p. 459.

A typical, though small, example of this species has been loaned by the Australian Museum. It was taken 20 miles north-northeast of Double Island Point, Queensland, in 30 fms. It measures a little more than 4 mm. across the disk, and the dingy, dirty whitish color indicates that it has been dried after being bleached by a long stay in alcohol. But it is of great interest as the first record of a true Ophiopteron from Australia.

Ophiomaza cacaotica

Lyman, 1871. Illus. Cat. M. C. Z., no. 6, p. 9.

This curious commensal, and possibly parasitic, ophiuran is common at Broome but we did not take it at Darwin. The reason of course is obvious — very few large comatulids were found at Darwin — they are abundant at Broome. Ophiomaza prefers comatulids of dark color and many arms; while occasionally found on Zygometra, it is most frequent on *Comanthina belli*. In life the color ranges from deep purplish-red or dark brown to nearly black; many specimens especially young ones are more or less marked with white, cream-color or yellow; these markings commonly consist of a broad stripe on upper side of arm, continued more or less onto disk along inner margins of radial shields, and arm-spines, more or less (usually the distal half) white; the interradial lobes of the disk, the oral shields and mouth frame, and occasionally some of the under arm-plates are other parts which may be white. A very striking example has a conspicuous white star on disk, with a small dark spot at center, and the points of the star extending out onto the basal half of the arms; the interradial lobes and arm-spines are also white. No constant correlation was detected between the color of the comatulid and that of the brittle-star. Of the 44 specimens at hand the smallest is 3 mm. across the disk, with arms 10 mm. long, and the largest has the disk 22 mm. in diameter and the arms 75 mm. long, a notable constancy in proportions. It is also notable that the number of plates covering the disk does not increase with increased size as much as might be expected, though there is great diversity among adults in the number and size of the plates on the central area of the disk.

Ophiocnemis marmorata

Ophiura marmorata Lamarck, 1816. Anim. s. Vert., 2, p. 543.
Ophiocnemis marmorata Müller and Troschel, 1842. Syst. Ast., p. 87.

This handsome brittle-star is very abundant in areas of fine sand in Roebuck Bay and southwestward along the coast. At extreme low tides it was interesting to walk about in their habitat and see how completely buried in the sand they were. Not even an arm tip was visible but the position occupied by the animal was evident, owing to the slight depression in the sand roughly similar to the form of disk and arms, probably the result of the settling of the sand as the animal ceases movement with the outgoing tide. The color of Ophiocnemis corresponds so closely in its tints and variegation with the sand in which it lives, that the resemblance may well be protective. When the tide was out large numbers of gulls were continually hovering over the areas where Ophiocnemis swarmed and it seemed as though the brittle-stars were the objects of interest. But I did not see an indubitable case of a gull picking up an ophiuran. The latter are so uniformly buried and move so little (with the tide out), it is probable that only those which become accidentally exposed are seized by the gulls. The 61 specimens at hand range from 3 to 21 mm. across the disk. The small ones are quite Ophiothrix-like.

OPHIOTHELA HADRA

H. L. CLARK, 1915a. Mem. M. C. Z., 25, p. 284.

We found Ophiothela fairly common on a sponge dredged near the Shell Islands at Darwin in July, 1929, but did not meet with it at Broome that year. In June, 1932, however, we took it repeatedly on gorgonians while dredging. These specimens show great diversity in size and some in color. My field notes say of the specimens taken at Darwin: "Extraordinarily bizarre coloration: black, white, yellow, red and dull green, quite irregularly massed but general impression of a group of specimens together was red and green — not bright however." In the larger dry specimens from Broome the disk is a deep purplish-red but the arms are decidedly variegated.

Whether *hadra* is really a valid species is still open to question but there is little doubt that all these Australian specimens represent a single form and are identical with the type of *hadra* and the specimens taken by the "Endeavour" referred to that species (H. L. Clark, 1916, p. 92). The cotypes of *danae* Verrill in the M. C. Z. have much longer arms than *hadra* and I am in doubt whether the two species are identical, but so far as I know all Australian material can be referred to *hadra*. Koehler (1907) referred specimens from Shark Bay and Albany to *danae* but *hadra* had not at that time been distinguished. In any case the occurrence of an Ophiothela at Albany needs verification.

In examining alcoholic specimens of the holothurian *Pentacta caerulea* taken at Broome in 1929, 5 small specimens of Ophiothela were found clinging tightly to them. As this Pentacta occurs frequently on alcyonarians it is not inexplicable how the little ophiurans came to be associated with the holothurians but it is I think the first case of the kind reported.

There are 109 specimens of Ophiothela in the present collection but nearly all are very young.

Queensland: Port Curtis. 27 specimens, adult and young. Loaned by the Australian Museum.

Northern Territory: Darwin, near Shell Islands, 3–6 fms. on a sponge, July 24, 1929. 22 specimens, young.

Western Australia: Broome: 5–8 fms., on alcyonarians, June, 1932. 55 specimens, adult and young.

Broome, on *Pentacta caerulea*, September, 1929. 5 specimens, very young.

OPHIOGYMNA ELEGANS

LJUNGMAN, 1866. Öfv. Kongl. Vet.-Akad. Förh., **23**, p. 163.

A single specimen of this brittle-star, 4.5 mm. across the disk, has been loaned by the Australian Museum. It was dredged off Norwest Island, Great Barrier Reef, Queensland, by Livingstone and Boardman, and is of great interest as the first Ophiogymna reported from Australia.

OPHIOGYMNA LINEATA[1] sp. nov.

Disk rather more than 4 mm. across but of irregular shape, covered with a loose, thin skin which is full of delicate scales. Radial shields relatively large, much longer than wide, somewhat triangular, but distal angle is wide and truncate and outer side is concave; the two shields of a pair have the inner sides in contact distally but a little separated within. Arms 5, very long and slender but so convoluted they cannot be measured, apparently 40–50 mm. in life and probably more. Upper arm-plates indistinguishable even under a magnification of 90 diameters; apparently there are many, irregular small, and even minute, plates imbedded in a thin skin covering the upper side of the arm; near the tip of the arm, the ends of the arm segments are thicker than the middle and there are indications that a very delicate ill-defined upper arm-plate, much longer than wide is present.

Interbrachial areas below covered with the delicate scale-bearing skin of the disk. Under arm-plates proximally small, wider than long not in contact with each other; each has a convex proximal border and a straight or slightly concave one distally; on the outer part of the arm, the plates are longer than wide and quite fully in contact. Arm-spines 5 or 6, the next to the uppermost (or second below) longest, translucent and finely thorny; the uppermost is acicular and more nearly smooth; the following 2 or 3 are rather blunt and a trifle curved near tip; the two lowest are very small. Tentacle-scale wanting, unless the lowest arm-spine is regarded as such.

Oral shields small, rhombic, wider than long, with rounded angles, the inner angle sharpest; madreporite largest, of irregular shape. Adoral plates relatively very large, not quite meeting at their somewhat pointed inner ends; at the outer end a large squarish lobe separates the oral shield from the arm-plates. Color of dry specimens, pale gray, the arm-spines and oral surface nearly white; the radial shields darker with a violet tinge. Along the upper side of the arm is a narrow but conspicuous median white line. Under high magnification the upper side of the arm shows a very evident light violet tinge.

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[1] *linea* = a line, in reference to the white lines on the arms.

Holotype, Australian Museum no. J 6045, from west of Low Islands, Great Barrier Reef, Queensland, 6–8 fms. on a mud and alcyonarian bottom. November 15, 1928.

There are 3 paratypes of this very distinct species, taken with the holotype. All were loaned by the Australian Museum. At first sight, the specimens look as though they had been somewhat decalcified by acid alcohol before being dried, but as examination under 90 diameters shows the teeth on the arm-spines absolutely untouched by any acid, it is unlikely any decalcification has taken place. Aside from the distinctive coloration which is identical in all four specimens, the characters of the disk, arm-covering and arm-spines combine to set this species apart from the other members of the genus. In the thin disk-skin with numerous obvious scales, *lineata* is less distant from Ophiothrix than is *elegans*.

OPHIOCHITONIDAE

Ophionereis schayeri

Ophiolepis schayeri Müller and Troschel, 1844. Arch. f. Naturg., **10**, p. 182.
Ophionereis schayeri Lütken, 1859a. Add. ad Hist. Oph., pt. 2, p. 110.

This common and well known brittle-star characteristic of the southern coastal fauna of Australia is represented in the present collection by 77 specimens from the following places. Since it occurs in New Zealand as well as Australia, its apparent absence from Lord Howe Island is of more than passing interest.

New South Wales: Colloroy, Long Reef, November 28, 1929. 1 specimen, very young.

Port Jackson, Bottle and Glass Rocks, November 27, 1929. 4 specimens, adult and young.

Port Jackson, near Middle Head, 6–8 fms., November 21, 1929. 22 specimens, adult and young. A field note says: "*O. schayeri* at Port Jackson has a decidedly red cast and looks very different from those found near Perth." Now in their dry condition, the red cast is quite gone but the coloration is noticeably darker than the Western Australian material.

Shell Harbor, May 4, 1932. 7 specimens, adult and young; adults, 23–24 mm. across disk.

Western Australia: Bunkers Bay, January 1930. E. W. Bennett leg. et don. 5 specimens, adult and young.

Bunbury, October, 1929. 1 specimen, adult.

Point Peron, October, 1929. 23 specimens, adult and young; largest 24 mm. across disk.

Rottnest Island, October, 1929. 9 specimens, adult and young, one only 2 mm. across disk.

Rottnest Island, January, 1934. Captain Beresford E. Bardwell leg. et don. 3 specimens.

Dongarra, April 10, 1928. E. W. Bennett leg. et don. 2 specimens, young.

OPHIONEREIS SEMONI

Ophiotriton semoni DÖDERLEIN, 1896. Denk. Ges. Jena, **8**, p. 288.
Ophionereis semoni KOEHLER, 1905. "Siboga" Oph. Litt., p. 54.

This species proves to be very common at Broome and we also took it at Darwin. It has not yet been reported from the coast west of Broome in the north[1] or west of Spencer Gulf in the south. Its occurrence in South Australia is puzzling since it is not known from either New South Wales or Victoria. The furthest south on the Queensland coast would seem to be at Lindeman Island, as reported below.

The specimens from Darwin are all rather small but are typical. At Broome, specimens 7 mm. across the disk were not rare and one 9 mm. in diameter was secured, the largest so far recorded. There is no little diversity in the arm bands and disk markings but a remarkably constant recognition mark is found on the lower surface: the oral shields are white, usually a very pure white, with the margins, or at any rate the adjoining tissues abruptly dark (dusky, brown or olive). The upper side of the disk commonly has a dark blotch at center, which may cover a large part of its surface but is irregular in form as well as size; usually it is finely speckled or reticulated with whitish. Very small specimens are not notably different from adults.

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[1] Unless Koehler's record (1907, p. 246) of *O. dubia* from Shark Bay really refers to this species, which seems probable.

The 40 specimens of *semoni* at hand are from the following places:

Queensland: Lindeman Island, Great Barrier Reef, near Mackay, 1934. M. Ward leg. et don. 1 specimen, adult.

Northern Territory: Darwin, near Shell Islands, 3–6 fms., July, 1929. 5 specimens, adult and young.

Darwin, near Leper Station, May, 1932. 3 specimens, small adults and young.

Western Australia: Broome, along shore, particularly at Entrance Point, August and September, 1929. 16 specimens, chiefly adult.

Broome, dredging in 5–8 fms., chiefly southwest from Roebuck Bay, June, 1932. 15 specimens.

Besides these typical examples of *semoni*, there are 2 small Ophionereis from the western coast of the continent whose status is very puzzling. Until more material is available they may be regarded as varieties of *semoni* but it will not be surprising if each proves to be a valid species. Both agree with *semoni* in having white oral shields, as well as in their structural characters. The individual which is the more like *semoni* comes from furthest south! It was taken at Point Peron by Professor Bennett who kindly sent it to me. It has the disk only 4 mm. across, so it is about half grown. The arms are nearly white, not at all grayish or dusky as in *semoni*, and every third or fourth segment is very dark, almost black, in marked contrast, but the dark area is not sharply delimited. The arm-spines are spotted or ringed with brownish as in *semoni*. The upper surface of the disk is nearly black with many small roundish spots of dirty white or yellowish and 3 large irregular blotches of the same light color on each interradial margin. The interradial areas below may be described as black with 10–12 large irregular whitish blotches, or as white handsomely reticulated with black. Oral shields and jaws white, the adoral plates brown in rather marked contrast, making a brown pentagon around the mouth. In view of this unusual and striking coloration, this specimen may be called *Ophionereis semoni* var. *nigra* but its near relationship to the related species *stigma* must not be ignored. The holotype is M. C. Z. no. 5203.

The other specimen is similar to the above in its banded white arms but the bands are not nearly so dark; they are dusky with a greenish tinge. The arm-spines are white not spotted or banded at all. The disk is a uniform chocolate brown with a few small spots of whitish and 3 or 4 elongated whitish spots or blotches along the interradial margins. The interradial areas below are dusky brown, each with 8–10 rounded whitish spots. The whole oral region is dusky brown except the teeth and a large rounded white spot on each oral shield. This variety is so markedly different from any other Ophionereis I have seen, it seems best to give it a name, so for the present it may be called *O. semoni* var. *badia* (=brown). The unique holotype (M. C. Z. no. 5204) was taken by Professor Bennett at Dongarra. It is not quite 5 mm. across the disk, and the arms, only about 25 mm. long, are obviously shorter than in typical *semoni*.

OPHIONEREIS HEXACTIS[1] sp. nov.

Disk very flat, smooth and thin, hexagonal, 4 mm. in diameter. Arms 6, about 30 mm. long, very slender and attenuate. Disk covered by a soft skin, crowded with very delicate more or less circular, minute scales only visible in dry specimens and under considerable magnification; no external evidence of radial shields. Upper arm-plates near base of arm rounded triangular, with a proximal base and a narrow distal tip; length equals or exceeds width; further out the plates become longer and narrower and are elongated pentagons, with rounded angles; supplementary plates very thin and hard to make out, but there is at least one on each side; additional supplementary scales of small size appear to be present but it is very difficult to distinguish them.

Interbrachial areas below covered like the disk with a delicate skin crowded with minute scales. Under arm-plates much longer than wide, especially distally; at middle of arm they are elongated pentagons with a more or less pointed proximal angle and a rounded distal end; the length is twice the width or more. Arm-spines 3, very slender but blunt and scarcely tapering; the middle one is longest and exceeds an arm-segment considerably. Tentacle-scale very large but thin somewhat longer than wide. Oral shields more or less nearly circular, the madreporite largest; the length may exceed the width and the inner end may be a trifle pointed. Adoral plates narrow at the inner end where they may meet but often do not; wide at the outer end where a distally projecting lobe separates the oral shield from the side arm-plate. Oral papillae 4 on each side, the outer one largest; all are narrow and bluntly pointed. Color of dry specimen: disk yellowish-gray; arms nearly white, with 9 or 10 very narrow dark bands; these bands are dusky with a purplish tint, but not black; upper arm-plates distally are sometimes quite gray; lower surface white, save for the yellowish-gray (almost greenish) interbrachial areas.

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[1] ἕξ =*six*+ἀκτὶς =*ray*, in reference to the number of arms.

Holotype, M. C. Z. no. 5205, from under a rock, East Point, Darwin, N. T., June, 1929.

This delicate little species is so much more fragile than young *semoni* of the same disk-diameter that it was recognized as different from the very first. There are 11 paratypes from East Point, of which 2 are pentamerous but not otherwise peculiar. The thread-like arms are very characteristic especially in life. My field notes at Darwin say of one of the paratypes: "Disk dull red, about 1.5–2 mm. in diameter; arms very slender, long (30 mm. ±) almost white with widely spaced black spots or cross bars. A very delicate creature on under side of a rock in tide pool. Disk seems very dark in contrast to white sparsely banded arms. Apparently lives on the sand under rocks; when they are turned over suddenly the brittle-star is drawn up with back to rock and lies (against its upturned lower surface) mouth up, and is then rather hard to see."

During one of our last days at Lord Howe Island, 2 small examples of this curious little Ophionereis were taken, my field notes saying: "Ophionereis sp.? 2 specimens, very small, on under side of rocks, far out on Neds Beach flat. Disk bright brown; 6 arms, white with widely separated narrow bands of red brown. Disk rather soft and dries to a much smaller size than in life." The occurrence of *hexactis* at Lord Howe is certainly surprising but probably it occurs all along the Barrier Reef.

OPHIONEREIS STIGMA[1] sp. nov.

Disk 7 mm. across. Arms 5, probably about 60 mm. long, but the tips are all missing. So similar to *semoni* in structural features that a detailed description is quite superfluous. Upper arm-plates wide and short with very acute lateral angles; in *semoni* the plates are relatively longer and narrower with less marked lateral angles; typical examples are obviously different but in small specimens this character is not easily recognized and even in some adults the difference isn't very satisfactory. In the under arm-plates however there is a noticeable difference which seems to be very constant. In *semoni* the under arm-plates expand distally so that they are somewhat bell-shaped, the distal end considerably wider than the proximal with angular corners, but in *stigma* the lateral margins of the plate are parallel and the distal margin is the same length as the proximal, while the corners are more rounded; moreover the distal margin is often concave or even notched, while in *semoni* it is usually somewhat convex. This difference in the under arm-plates can be detected even in very young specimens.

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[1] *σπίγμα* = *a mark*, in reference to the conspicuous brown mark at the base of each arm.

Another character that is evident enough in adults but rather indefinite in young specimens is associated with the mouth parts; in *semoni* the mouth-frame and oral shields are more or less covered by a skin which obscures the adoral plates and even the boundaries of the oral shields and in adult specimens no plate boundaries can be made out. In *stigma*, there is no such skin but even the adoral plates can be easily seen.

In coloration, the differences are so evident in life that the species are instantly recognizable, only very small specimens requiring much care. In mature *stigma*, the disk is pale gray (or whitish or yellowish) with a coarse network of dark brown lines; at the base of each arm is a peculiar mark of dark brown or black, which appears first in very young specimens as an elongate spot between the proximal ends of the radial shields; the distal end of this dark area forks and one-half extends across each radial shield and then bends outward to the disk margin beside the arm-base, where it may run inward almost to the middle of the interradial area; usually this mark is not as complete as described above; it may remain as a single longitudinal mark between the radial shields or more commonly it becomes a horizontal, irregular, narrow blotch across the shields or along the margin of the disk interradially; sometimes the dark brown color forms a spot at the inner end of the radial shields whence it spreads inward onto the disk and not distally at all. One might almost say that in no two specimens are the details of the "stigma" exactly alike, but in very few specimens indeed is it inconspicuous. As a rule the arms of *stigma* are lighter colored than those of *semoni* and the dark cross bands are more frequent and wider. On the oral surface, the differences are evident; in *stigma* the light colored distal portion of each interbrachial area shows a coarse network of dark lines but these merge together proximally so that just outside the oral shield each area is dark brown, and a dusky area extends inward onto the light colored shield, or there may be one or two distinct spots on the shield — very different from the dusky bordered white oral shields of *semoni*.

Holotype, M. C. Z., no. 5209, from under a rock, at Cape Leveque, W. A., August, 1929.

The superficial resemblance of this species to *semoni* is obvious but they are really quite distinct and adult specimens are easily distinguished. At Broome, both species were common at Entrance Point and at Gantheaume Point. At False Cape Bossut, *stigma* was abundant but we did not note *semoni*. Oddly enough at Cape Leveque also we found only *stigma*. At Darwin only *semoni* was collected. Neither species grows to a large size and most of the specimens found are young. Owing to their secretive habits and the similarity between their coloration and that of their habitat, either species might be easily overlooked.

The 67 specimens of *stigma* at hand are grouped as follows:

Western Australia: Cape Leveque, August, 1929. 7 specimens, adult and young.
Broome, chiefly at Entrance and Gantheaume Points, August and September, 1929. 32 specimens, adult and young.
False Cape Bossut, September 8, 1929. 15 specimens.
Broome, chiefly by dredging in 5–8 fms., June, 1932. 13 specimens, adult and young.

OPHIONEREIS TIGRIS[1] sp. nov.

Plate **25**, fig. 6

Disk 4.5 mm. across. Arms 5, about 35 mm. long. Similar to *O. semoni* in its structural features but the skin of the oral surface is so thick that not even the oral shields are distinguishable. Coloration most striking. Disk, above and below pale yellow, with bold irregular lines of purplish-brown; in the interbrachial areas orally there are 3 lines running inward from margin, the middle one longest and extending onto the jaw but not to the teeth, the ones on either side extend only to the third or second arm-segment; on the aboral surface of disk the lines, though few, are too irregular, to permit detailed description. Arms banded whitish and purplish-brown with surprising uniformity, to the very tip; with extremely few exceptions, dark and light segments alternate regularly. Arm-spines distally white but on proximal portion of arms they have a dusky spot or band on basal half.

Holotype, Australian Museum, no J6050, from Norwest Islet, Queensland. May, 1930. Melbourne Ward leg.

This beautiful, and unfortunately unique, specimen was loaned by the Australian Museum. It is so very different from any other Ophionereis I have seen, I cannot doubt it represents a hitherto unknown species.

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[1] *tigris* = a tiger, in reference to the color and markings of the disk.

OPHIOCOMIDAE

OPHIOCOMA BREVIPES

PETERS, 1851. Monatsb. K.-Preus. Akad. Wiss. Berlin, p. 465.

This handsome species was met with only at Lord Howe Island where it is not very common under stones among the coralline algae at Neds Beach. It is even less common on the reef-flat near Mt. Lidgbird. Young specimens less than 8 mm. across the disk are very light colored, almost white, with no green, the bands on the arms and the few lines on the disk being dusky. As they become larger, they become darker and the green color appears. There is little change in relative length of arms however, for the smallest of the 8 specimens at hand, an individual 4 mm. across disk, has arms 16 mm. long while the largest with disk 16 mm. across has arms little less than 4 times as much. The larger specimens have the disk handsomely variegated with light and dark green. The habits of *brevipes* at Lord Howe were surprisingly sluggish. They crowded into holes and crannies and remained perfectly quiet when exposed, the arms drawn up as snugly about the body as possible.

OPHIOCOMA CANALICULATA

LÜTKEN, 1869. Add. ad Hist. Oph., pt. 3, p. 46.

There is a fine series of 93 specimens of this Ophiocoma at hand, ranging in disk diameter from 2 to 21 mm. It has heretofore been considered a rare ophiuran but the collecting in 1929 showed it to be common at Port Willunga, S. A. and at Point Peron and Rottnest Island, W. A. Professor Bennett also found it common at Bunkers Bay, but there are no specimens available from Albany or Bunbury, which seems a little odd. It has not been taken at Dongarra or the Abrolhos and Michaelsen and Hartmeyer did not meet with it during their extensive collecting in Western Australia in 1905. That its range extends eastward to the New South Wales coast was revealed by our taking a typical specimen at Shell Harbor.

On the whole this large series of specimens shows no notable diversity in structural features but a good deal in coloration. The smallest specimen (2 mm. across disk) is variegated with pale red and white, and shows no definite white line on lower side of arm; it was taken at Bunkers Bay and is dry and possibly somewhat bleached. Some small specimens from Rottnest Island, 3–4 mm. across, have the disks dark grayish-brown, the arms somewhat lighter; in 2 cases, the arms are distinctly banded with white and in a third many under arm-plates are white; only 1 shows the beginnings of the characteristic white stripe on the lower surface of the arms. Most individuals above 5 mm. across the disk show this white stripe plainly but sometimes only on the basal part of the arms; in very large specimens it often becomes quite indistinct, though traces of it can usually be made out. The ground color of preserved material ranges from light brown or grayish to nearly black; in many specimens there is a very evident reddish or claret tinge; one very small specimen from Port Willunga, is uniformly rusty red but this may be an accident of preservation.

As for the color in life, my field notes at Port Willunga, S. A., say "all uniformly black in life with a reddish cast on sides and orally." The reddish tint is quite lacking in the dry specimens. My notes at Point Peron say: "color in life pale olive, light brown or dark brown." It is very noticeable that specimens from the west coast are very much lighter than those from Port Willunga. The specimen from Shell Harbor is dark with a definite reddish-purple tint. Many of the dry specimens from Bunkers Bay are very light brown but it is impossible to say how much of this may be artificial.

The specimens at hand are from the following places:

New South Wales: Shell Harbor, May 4, 1932. 1 specimen.
South Australia: Port Willunga, November 2, 1929. 14 specimens, adult and young.
Western Australia: Bunkers Bay, January, 1930. E. W. Bennett leg. et don. 19 specimens, adult and young.
Point Peron, October, 1929. 33 specimens, adult and young.
Point Peron. E. W. Bennett leg. et don. 22 specimens, adult and young.
Rottnest Island, October, 1929. 3 specimens, very young.
Rottnest Island, 1931. G. Bourne leg. 1 very young specimen.

OPHIOCOMA ERINACEUS

MÜLLER and TROSCHEL, 1842. Sys. Ast., p. 98.

This species was fairly common at Lord Howe Island but we did not meet with it elsewhere. It occurred under rocks on the reef-flat near Mt. Lidgbird and was abundant at Neds Beach, among the corals. No specimens of the closely related species *scolopendrina* or *schoenleinii* were found. Very small specimens of *crinaceus* have the arms more or less evidently banded and often show white on disk margins and lower surface of arms but the short arms will help to distinguish them from young *scolopendrina*. Large specimens often have the uppermost arm-spines more or less enlarged and such specimens are sometimes mistaken for Ophiomastix, from which genus the disk covering always distinguishes them. The 22 specimens of *crinaceus* at hand range in disk diameter from 3 to 26 mm. The absence of Ophiocomas from the coasts of northern and northwestern Australia is a very unexpected feature of the ophiuran fauna there.

OPHIOCOMA INSULARIA var. VARIEGATA

Ophiocoma insularia LYMAN, 1861. Proc. Boston Soc. Nat. Hist., **8**, p. 80.
Ophiocoma variegata E. A. SMITH, 1876. Ann. Mag. Nat. Hist. (4) **18**, p. 39.

The opportunity to renew my acquaintance with *Ophiocoma brevipes* at Lord Howe Island made it easy to take the first step in untangling the forms having a finely granulated disk-covering extending clear to the oral shields. In my revision of the genus (1921, pp. 120–132) they were all grouped under the specific name *brevipes* Peters but I expressed my dissatisfaction with this arrangement and stated (p. 130) my belief in the possibility that at least one of the varieties proposed "is really a distinct species." At Lord Howe, the habits and habitat of *brevipes* were as distinctive as its greenish and white coloration and its short arms. Hence there was no possibility of confusion with the present form. There were no connecting links seen and no doubt remains that *brevipes* is a well-marked species quite distinct from the present stouter, dark-colored form which has been called *variegata*. Lyman's name *insularia* was however the earliest name given to the dark-colored Ophiocomas with fine disk granulation and must be used for the uniformly dark ones occurring at the Hawaiian Islands. The similar Ophiocoma with a variegated coloration to which Smith subsequently gave the name *variegata* may possibly be entitled to specific rank but the matter is still open to question and further field work is needed. At Lord Howe typical *insularia* was not found but *variegata* is very common and 24 specimens are at hand. They range from 4 to 34 mm. in disk diameter and the arms are about 4 times as much. Obviously the difference in arm length between typical *brevipes* and *variegata* is insignificant, though in the former it may be as little as 3 times the disk diameter. But *brevipes* is a much smaller species and conspicuously different in coloration.

At Lord Howe, fully grown *variegata* fall into one of the two color forms to which names were long since given. The more common of these of which 12 specimens large and small are before me, is *dentata* Ltk. in which the disk is handsomely reticulated with dark brown lines on a lighter background; the ground color may be gray or brown; one specimen was taken in which it was fawn-color; in preserved specimens it sometimes shows a yellowish tint; the size of the meshes in the network shows some diversity but as a rule the larger the disk, the smaller the meshes. The other form, named *doederleini* by de Loriol, has the disk spotted with black; it is less common and only 4 specimens are at hand. In one young specimen, the disk is dark gray and buff so the black spots are conspicuous but in large individuals the ground color is so dark the spots do not stand out well in dried specimens; they are more evident in life. In both *dentata* and *doederleini* the arms are more or less conspicuously banded with shades both lighter and darker than the ground color. In young specimens in which the disk is neither reticulate nor spotted, the banding of the arms or their variegation with light and dark shades, is very conspicuous; there are 8 such specimens at hand with disk-diameter ranging from 4 to 8 mm.

OPHIOCOMA PARVA

H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 292.

It is evident from the present series of specimens, that this odd little Ophiocoma may be expected on the Australian coast wherever there is sufficient coral. Its apparent absence from Darwin and Broome may be due to the absence of such coral areas as it likes, but it will probably be found at Darwin when satisfactory tides enable the collector to get further out at East Point than we were able to do. It is very common at Lord Howe particularly in the coral at Neds Beach where it reaches the largest size yet recorded; a very symmetrical specimen is 7 mm. across the disk, with arms 28 mm. long. Most of the specimens are brown or dusky and pale gray or whitish. Few show any greenish tint but several are more or less yellow-brown; one large specimen has the disk and arm bases yellow-brown but the arms quickly become dusky and whitish; very small specimens have the arms variegated with white and dusky; the banding of the arms is a conspicuous feature of most specimens. Alcoholic specimens are the same color as the types from Mer. The Rottnest Island specimens are yellow-brown with only faint banding on the arms; they appear to have been in alcohol for some time before being dried.

Autotomy is very evident in most of the specimens at hand; conditions range all the way from individuals with 3 arms and half a disk to the symmetrically hexamerous adults; many specimens have 3 large and 3 small arms. There are 2 7-armed specimens but neither is symmetrical — one from Lord Howe has 3 large and 4 somewhat smaller arms but the 4 are not all the same size; the other, from Rottnest, is similar but the disk is not normal and seems to have been regenerating poorly. From Lord Howe there is one pentamerous specimen, with 3 large, normal arms and 2 very small ones, while from Rottnest there is a symmetrical pentamerous specimen 4.5 mm. across the disk and another somewhat smaller individual with 4 large and one small arm.

The occurrence of *parva* at Cape Leveque was unexpected but not surprising as there is much suitable coral there. It was however most unexpected to have it appear at Rottnest, but Mr. Duncan C. Swan wrote me of the conditions at the west end of the island as being very different from the area that I saw at the northeastern corner. He writes of "a raised, level, rocky platform onto which spent waves occasionally broke. The temperature of the water was much higher than the normal sea-water and close by were isolated colonies (a few feet across) of the true coral-reef coral Pocillopora." Professor Bennett writes that specimens of "a coral-crab, Trapezia, like those of Queensland" were found here "so that the echinoderms from here may considerably extend the range of some of the northern species." This proved an excellent prophecy but of no species was it more surprising than of *Ophiocoma parva!* The color of the Rottnest *parva* is a light yellow brown but it is probable they were in alcohol for some time.

The 45 specimens of *parva* at hand are from the following widely separated stations:

Lord Howe Island: Reef-flat near Mt. Lidgbird, but chiefly from corals at Neds Beach, April, 1932. 36 specimens, adult and young.

Northern Territory: Coburg Peninsula, Port Essington, Coral Bay, May 21, 1932. 1 specimen, young.

Western Australia: Cape Leveque, reef-flat, August, 1929. 2 specimens, adult and young.

Rottnest Island, western end near Cape Vlaming, February, 1930. Swan and Drummond leg. E. W. Bennett don. 6 specimens, small adults.

OPHIOCOMA PICA

MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 101.

It was a pleasant surprise to find this very handsome brittle-star at Lord Howe for it has not previously been recorded from south of Mer, at the northern end of the Barrier Reef. It is not abundant at Lord Howe but we secured 7 specimens, ranging from 10 to 26 mm. across the disk; the last is the largest specimen as yet recorded; its arms are very short, scarcely 70 mm. The species has a wide range, from Zanzibar and the Red Sea to Hawaii and the Paumotus, but we did not find it anywhere on the mainland coast of Australia.

OPHIOCOMA PULCHRA

Ophiocoma canaliculata var. *pulchra* H. L. CLARK, 1928. Rec. S. Austral. Mus., **3**, p. 439.
Ophiocoma punctata KOEHLER, 1930. Vid. Med., **89**, p. 205.

When Koehler prepared his excellent description and photographs of the Ophiocoma taken by Dr. Mortensen in Port Jackson, my account of the same species was still unpublished. As his bibliography ends with 1927, my paper published in May, 1928, was very naturally not included. It is unlikely that Dr. Koehler ever thought of finding in it any account of one of his forms then awaiting publication. Fortunately the name I proposed is equally appropriate with Koehler's and its necessary use therefore need not be regretted. Whether *pulchra* is really a species distinct from *canaliculata* as Koehler believed seems to me still open to question. The range of the two coincides and the structural features are remarkably similar, but as no intermediate specimens have been seen, it is probably best to call them by different names. Nevertheless it should be noted that the two forms occur together at Shell Harbor and at Bunkers Bay.

The specimens at hand show that *pulchra* has a very wide range, nearly equal to that of *canaliculata*, extending from Long Reef, above Port Jackson to Bunkers Bay on the southwestern corner of the continent. The small individual from Bunkers Bay (10 mm. in disk-diameter) is unusual in being quite gray with only a tinge of claret-red on the upper side of the arms; the red is more in evidence around the mouth and on the under arm-plates. The specimen most like it in this duller coloration is one of those from Long Reef. The Shell Harbor specimens are markedly reddish but of a dark shade. The most strikingly colored specimens apparently are those taken in St. Vincent and Spencer Gulfs on the South Australian coast on which *pulchra* was based in 1928.

The 5 specimens of *pulchra* at hand are from the widely separated localities already mentioned.

New South Wales: Colloroy, Long Reef, Professor W. J. Dakin leg. et don. 2 specimens.
Shell Harbor, May 4, 1932. 2 specimens.
Western Australia: Bunkers Bay, January, 1930. Professor E. W. Bennett leg. et don. 1 specimen, small adult.

OPHIOCOMA OCCIDENTALIS[1] sp. nov.

Plate 25, fig. 1

Disk 26 mm. in diameter. Arms 5, relatively short and rather stout, about 90 mm. long. Disk closely covered with a rather coarse granulation (30–50 to the square millimeter); the granules are perhaps a little larger near the interradial margins but are not at all elongated there. Upper arm-plates much wider than long, unequal in size, irregular in shape, often asymmetrical; a typical plate is about twice as wide as long, triangular, with the proximal angle truncate, the distal margin convex, the lateral angles sharp and the lateral margins a trifle concave. But two successive plates are seldom just alike; a typical plate will be followed by one 3 x as wide as long or by one almost as long as wide and there is no regularity in sequence; apparently more plates are atypical and asymmetrical than are perfectly typical. Distally the plates decrease much in size, become more regular, more equilaterally triangular, and ultimately are quite separated by the large side arm-plates.

Interbrachial areas below large, closely covered with thin overlapping scales; the granules from the disk pass over the margin onto these areas but become more and more sparsely scattered both at the sides and near the oral shield, so that proximally the areas are quite naked. First under arm-plate small and nearly square, the following are much larger, at first hexagonal, then octagonal with distal corners rounded and width greater than length; near middle of arm length and breadth become equal and all angles are rounded so that some plates are nearly circular; at the tip of the arm the plates are longer than wide and finally are separated by the meeting of the side arm-plates. Arm-spines relatively short and

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[1] *occidentalis* = western, in reference, of course, to its Australian habitat.

stout, often a trifle curved, and slightly flattened, very blunt; there are 3 or 4 on each side arm-plate; when 3, the uppermost is the largest, its length about equal to width of arm; when 4 are present, the uppermost is very much the largest, about equal to 4 arm-segments in length and a millimeter or more in thickness; the tip is often flattened and sometimes widened, but is never clavate in the proper sense of that word; all the spines are smooth; there is neither regularity nor symmetry in the distribution of the large spines but they occur every 1–4 segments nearly to the tip of the arm. Tentacle-scale single, very large, more or less circular, though the width is greatest at base; on 6–8 of the basal pores, 2 scales of more or less nearly equal size are present.

Oral shields almost circular, except that the madreporite which is much the largest, is considerably wider than long; the others are perhaps a trifle longer than wide; this shape however, while fairly typical of adults, is a little extreme, for many specimens especially smaller ones have the shields much longer than wide and narrower at the inner end; in some cases the inner and outer ends are both square cut so the shields are oblong with corners very little rounded. Adoral plates are narrow and crescentic, the outer end wider than inner; they lie close to the sides of the oral shields and do not come anywhere near meeting within.

Color of dry specimen, deep chocolate brown, the arms irregularly but definitely banded with a lighter shade; nearly all the smaller arm-spines, but not the very large ones, have a definite longitudinal light stripe, more evident when seen from below; oral shields, under arm-plates and tentacle-scales have more or less evident light edges; oral papillae yellowish. In most specimens there is more or less of a claret-red tint especially on the upper arm-spines and plates and this may be quite evident. At the other extreme are specimens which are quite gray and one young specimen has the disk quite black. In all cases, the lighter colored areas on the arms show under a lens, a more or less definite mottling with the darker shade of the upper arm-plates; this is most conspicuous in gray specimens. In the youngest specimens, the variegation with light (whitish or nearly white) and dark (dusky) on the oral shields and basal under arm-plates is very noticeable and often quite pretty. In regard to the color in life, my field notes say concerning the specimens taken at Point Peron: "Deep red, more or less variegated with whitish on arms and arm-spines. A lovely thing and colors not so fugacious as reds usually are but comes out readily in $Mg\ SO_4$ and colors other things." Some alcoholic specimens retain a reddish tint but many have lost it completely.

Holotype, M. C. Z., no. 5239, from under a rock at Point Peron, Western Australia. October, 1929.

Koehler has recorded (1907, p. 246) *Ophiocoma wendtii* from Shark Bay, and it seemed probable that these Ophiocomas from near Perth would prove to be the same species. But the more one examines Koehler's accounts and figures of *wendtii* the more dubious one becomes as to the validity and status of the species. There seems to be no doubt that two quite different species are at present confused under the name; certainly Koehler's 1907 figure (Pl. XIII, fig. 38) and his 1922 figure (Pl. 75, figs. 7 and 8) cannot represent the same species. As I have used the name *wendtii* for the former, a species with handsomely ringed arm-spines, the second form needs a name. But the distinguishing characters of this second form are so vague, I cannot formulate them. The present species however is a very distinct one, the red coloration being notably different from that of any other member of the genus. It is, of course closely related to both *aethiops* and *schoenleinii* but may be distinguished from the former regardless of color, by the short arms, the shape of the under arm-plates, the longer arm-spines of very different shape and the larger more generally single tentacle-scale; from *schoenleinii*, it differs in color, in length of arms and arm-spines and in shape of under arm-plates, but particularly by a curious difference in the surface of the side arm-plates — in both *aethiops* and *occidentalis* the side arm-plates have a smooth surface like that of the under arm-plates so that there is no contrast between the two but in *schoenleinii* the surface of the side arm-plates is like shagreen in marked contrast to the smooth under arm-plates. The differences between *occidentalis* and the other species of southwestern Australia are great and obvious but the character of the arm-spines, the shape of the under arm-plates and the presence of a single large tentacle-scale are the most striking.

This notable Ophiocoma is very common at Point Peron, where 42 of the present series were taken by Professor Bennett and myself. There are 6 specimens from Rottnest Island, the gift of either Captain Bardwell or Professor Bennett, but I did not find it there in October, 1929. Finally there are 2 specimens of moderate size and very gray coloration which were sent by Professor Bennett but for some reason they now lack a locality label and I do not know where they were taken. It may have been Bunkers Bay but it is quite as likely that they are from Point Peron.

A very remarkable specimen was found at Point Peron in October, 1929. It is an albino of such striking character as to warrant description. It is an adult 20 mm. across the disk with arms a bit more than 60 mm. long. In life it was an almost uniform cream-color with dusky or reddish spots and markings on the upper arm-plates and on the arm-spines. The dry specimen is pale brown. The upper arm-plates and the large upper arm-spines still have considerable pigment especially in the distal half of the big spines. The lower surface is entirely lacking in pigment. In all structural characters the specimen is a normal *occidentalis*.

Ophiomastix notabilis[1] sp. nov.

Disk 13 mm. in diameter. Arms 5, rather slender and distinctly flattened, about 65 mm. long. Disk covered with a smooth skin scattered over which are minute, relatively thick, blunt spinelets (fig. 27); these spinelets are about .20 mm. long and occur irregularly about 1 to 6 on every square millimeter. Upper arm-plates much wider than long, scarcely at all angular but somewhat elliptical, with the proximal side flattened, where they are broadly in contact; the lateral margins are not evenly rounded but there are no evident angles.

Interbrachial areas below covered like the disk above with a skin bearing scattered minute spinelets. First under arm-plate very small, longer than wide; second much bigger but small and square; succeeding plates oblong, wider than long with nearly straight margins, and corners, more evidently the distal ones, rounded; the plates are not in contact with each other but are separated by shallow transverse grooves. Arm-spines 3 or 4, the uppermost longest; when only 3 are present the uppermost is not conspicuously different from the others and its length scarcely equals the width of the arm; when 4 are present, which occurs every 3 or 4 joints, the uppermost is conspicuously thickened, so that it is relatively very stout; its length about equals the arm-width and its tip is not at all clavate or even truncate, as a rule, but tends to be rounded. Tentacle-scale single, relatively large, much longer than wide, flat and rounded at tip.

Oral shields nearly circular or elliptical and longer than wide; madreporite a little the largest. Adoral plates small, their outlines obscured even in the dry specimen, by skin but apparently not nearly meeting within.

Color of dry holotype, disk above and below uniform shining jet black, with no markings of any sort. Upper side of arms black but at intervals of 5 or 6 joints (or only 4 distally), a white or cream-colored band crosses including the proximal half of an upper arm-plate; near the tip of the arm the whole plate is involved. Mouth frames and under arm-plates dark brown; oral and dental papillae, yellow; oral shields whitish with dusky or brownish margins; groups of under arm-plates, ranging in number from 2 to 9 are cream-color; the groups are separated from each other by from 1 to 5 brown plates. The arm-spines tend to be white where the cross bands on the arm are white but are not consistently so; often the uppermost spine is white only at base. The uppermost spines are usually blackish but distally, like most of the smaller (lower) spines they show more or less of a tendency to have light rings; on the small spines, there are generally 3–5 such rings; seen from above this banding of the spines is not conspicuous. Tentacle-scales the color of the adjoining under arm-plate.

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[1] *notabilis* = notable, of obvious application.

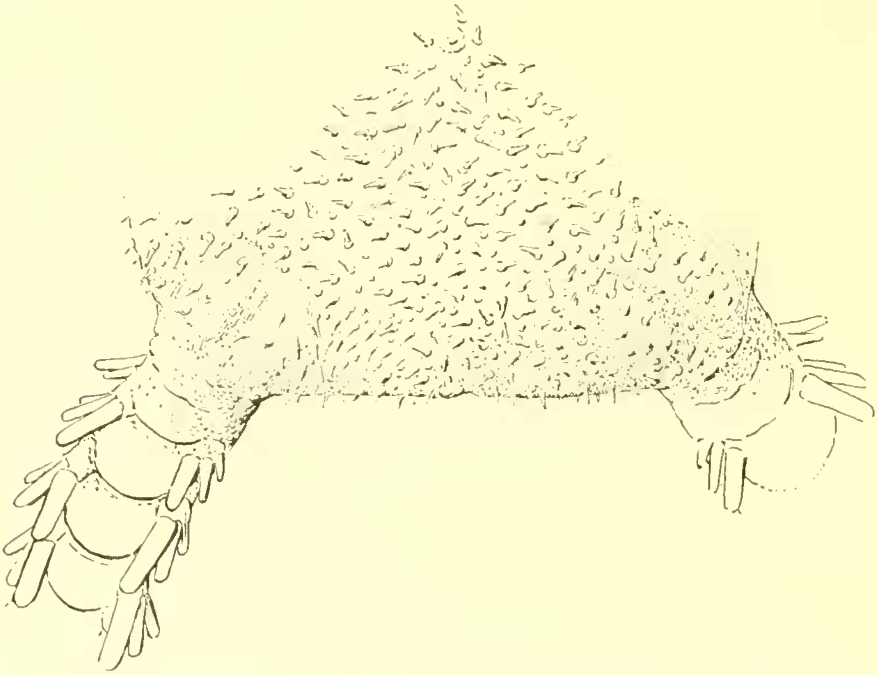

Fig. 27. Ophiomastix notabilis. Bases of 2 arms and portion of disk, to show disk covering and thick upper arm-spines. x 8.

Holotype, M. C. Z., no. 5247, from a coral colony at Cape Leveque, Western Australia, August 22, 1929.

The discovery of this specimen was the most notable of those made at Cape Leveque for it is the only specimen of the Ophiocomidae which we took on the whole northern coast of Australia. It was crowded into a cranny in a colony of some stony coral, in a tide pool, accessible only at very low water, and was discovered only in the course of breaking up the colony with a hammer for the purpose of uncovering brittle-stars and small holothurians. The color in life was definitely black and white but on preservation the white became yellowish. The species is very distinct from all the known members of the genus but the coloration alone will make its recognition easy.

OPHIARTHRUM ELEGANS

PETERS, 1851. Monatsb. K.-Preuss. Akad. Wiss., Berlin, p. 464.

Although this handsome brittle-star ranges from Zanzibar to Tahiti, we did not find it anywhere on the Australian Coast or at Lord Howe Island. Yet it is common at Thursday Island and on the Barrier Reef at least as far south as Cairns. It was therefore a pleasant surprise to find 12 typical specimens in the material collected by Captain Bardwell at Augustus and Champagay Islands in October, 1933. They range from 12 to 18 mm. in disk diameter, and show a curious dichromatic condition which is worthy of mention. Of the 12 specimens, 5 are distinctly yellowish and 7 are definitely gray; both have the usual dark disk and the customary speckling of arm-plates and arm-spines but the ground color is notably different in the two forms. It would be interesting to know if this difference is associated in any way with habitat. Since Ophiarthrum proves to be common at Augustus Island, it seems strange that we did not find it at Cape Leveque where conditions would seem to favor its occurrence.

OPHIARTHRUM PICTUM

Ophiocoma picta MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 102.
Ophiarthrum pictum LYMAN, 1874. Bull. M. C. Z., **3**, p. 225.

Mr. Ward has sent a very fine specimen of this splendid ophiuran which he took at Lindeman Island in 1934. It is of maximum size, nearly 30 mm. across the disk, which, even though dry, still shows well the remarkable yellow markings characteristic of the species. As *pictum* has not previously been reported from south of the Low Islands, its occurrence at Lindeman Island is notable.

OPHIODERMATIDAE

OPHIURODON CINCTUM

Ophioconis cincta BROCK, 1888. Zeit. f.w. Zool., **47**, p. 480.
Ophiurodon cincta MATSUMOTO, 1917. Mon. Jap. Oph., p. 315.

We met with an Ophiurodon at both Darwin and Broome which is apparently *cinctum* but the specimens were usually small and often in poor condition. The material at hand is not sufficient therefore for a critical study of this

East Indian species, of which our knowledge is based on very few specimens. No examples of Ophiurodon from north of Torres Strait are available to me except a single small individual from the Philippine Islands, which seems to belong to Koehler's species *cupidum*.

The specimens found at Darwin were taken either from a coral rock fragment on Three-and-a-half Mile Reef (1 specimen) or while dredging in 3–6 fms. near the Shell Islands (2 specimens). The largest of these is scarcely 5 mm. across the disk. They agree in coloration, having the disk uniformly light dull yellowish and the arms banded with white and dusky; the bands are distinct but ill-defined; usually there are 2 or 3 white segments followed by one or two dusky ones; the dusky bands are often much darker distally than proximally. These specimens agree in all essentials with Brock's (1888) and Koehler's (1905, 1922) accounts except that there are 2 tentacle-scales on all pores beyond the first 2 or 3, which have 3–5 scales. Brock says there is but one scale and Koehler said "unique" in 1905, but in 1922 (p. 352) he says that there are "sometimes" two. The second scale lies at the outer side of the pore and is, I believe always present, but it is only about half as large as its fellow, is nearly circular, very thin and transparent, and overlies the base of the lowest arm-spine; it is accordingly very easily overlooked even with high magnification. The marginal disk spinelets are present in the Darwin material and fairly conspicuous; in one specimen similar spinelets are present on the disk itself, scattered irregularly among the granules, as in Koehler's species *permixtum* (1905, p. 14).

The material from the Broome region consists of a large and perfect specimen from Cape Leveque, which is 6 mm. across the disk and has arms 20 mm. long; 2 much smaller specimens taken at Gantheaume and Entrance Points, Broome, in September, 1929; and 5 specimens, of which only one is adult, dredged in Roebuck Bay and southwestward in June, 1932. Only 2 have the marginal spinelets as well developed as in the Darwin specimens and in several no such spinelets are visible. It is evident that not much reliance can be placed on the presence, distribution or absence of these spinelets as a species character. But in one particular these 8 specimens from the Broome region agree in differing from Brock's specimen and those from Darwin, and that is the coloration, more particularly that of the disk. The arms are banded as in the Darwin specimens but the bands are more conspicuous, better defined and possibly more numerous. The disk is always prettily variegated with a light (white, cream-color or pale yellow) ground color, and dark (brown, red-brown or dark red) markings; in 4 of the smaller specimens the dark color makes an irregular star-like figure, with a light central area, each ray of the star extending to the base of an arm; in the other 2 small individuals the star is present but the light central area is broadly connected in one interradius with the outside light-colored portion of the disk; in the 2 large individuals, the dark color has extended to cover most of the disk, which is best described as dark with light interradial and central markings. Since this striking coloration is characteristic of all the Broome material and is lacking in those from Darwin, it is advisable to indicate it nomenclaturally. The variety may then be called *pulchellum* and the specimen from Cape Leveque (M. C. Z. no. 5252) be considered the holotype.

Ophiarachna megacantha[1] sp. nov.

Disk 15 mm. in diameter, rather definitely pentagonal. Arms 5, about 70 mm. long, not very wide, tapering steadily to the slender tip. Disk (fig. 28) covered with a uniform coat of fine granules about 100 to the square millimeter; radial shields naked but very small, 1.5 mm. long by 1 mm. wide; the two of a pair are nearly 3 mm. apart. Upper arm-plates on basal half of arm oblong, about twice as wide as long, in contact the full width of arm; lateral margins a little convex and distal corners somewhat rounded; distally they become squarish and finally triangular, and quite separated from each other by the side arm-plates.

Interbrachial areas below (fig. 29) closely covered by granules like the disk. First under arm-plate rather small, much wider than long, with a strongly convex distal margin; second plate larger and longer but still wider than long; succeeding plates becoming distinctly longer than wide only at and beyond the middle of arm; distal corners of plates rounded so that distal margin seems quite convex. The pores which occur in pairs between the basal under arm-plates of many Ophiodermatidae are plainly evident, but as the plates are broadly in contact it is hard to say how far out on the arm they extend. Arm-spines either 5 or 4; when 5 are present, the uppermost is shorter than the one below it; and that spine is longer than the 2 below it; the lowest is much the longest of the series; when 4 are present, the uppermost is longer than the two below it but does not equal the lowest; the lowest is wide, somewhat flattened, very blunt and equals or exceeds two arm-segments; between the 9th and 30th segments, these spines are conspicuously enlarged at frequent but irregular intervals; the largest are 4 mm. long and .75 mm. wide. The normal spines, above the lowest, are somewhat

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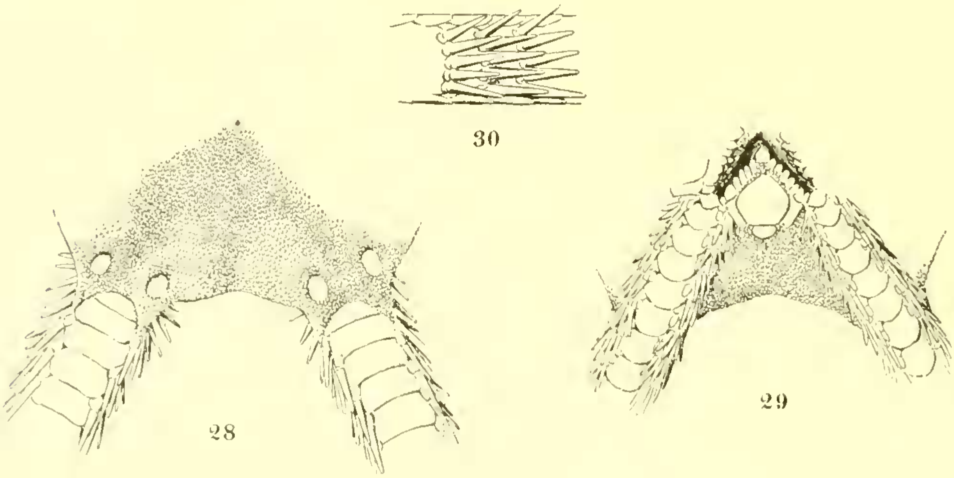
[1] *μεγάς = big + ἄκανθα = a spine*, in reference to the unusually large lower arm-spines.

flattened, wide at base and bluntly pointed; frequently they are a trifle curved; they all exceed an arm-segment in length and sometimes are nearly equal to 2. Tentacle-scales 2, large; inner about half as wide as outer which is nearly circular and overlies the base of the lowest arm-spine; in length the scales hardly equal one-half of the under arm-plate.

Oral shields large, pentagonal with rounded corners as wide as long or wider; madreporic plate not larger than the others. Supplementary plates distal to the oral shield small but distinct in all five areas. Adoral plates small, lying wholly at the sides of the oral shields and separating them from the first side arm-plates. Oral papillae 7 on each side of each jaw, the penultimate much the largest, twice as wide as the more proximal ones which are more or less pointed.



Figs. 28–30. Ophiarachna megacantha. x 4.
28. Dorsal surface of 2 arm-bases and part of disk.
29. Ventral view of same.
30. Side view of 3 arm-segments.

Color of dry holotype, disk uniformly light gray above, the disk granules a trifle more brown than the radial shields. Upper arm-plates at base of arm gray, like radial shields, but after the first half dozen plates or so, 2 or 3 plates are lighter and for the entire length of the arm there is a somewhat irregular alternation of the lighter and darker tints so that the arms appear faintly banded; the lateral margins of all upper arm-plates are narrowly white but this is not conspicuous. Arm-spines nearly white, especially the lowest ones; none are marked or banded in any way. Under arm-plates pale gray with white lateral margins. Tentacle-scales nearly white. Interbrachial areas below very light almost cream-color.

Oral shields very pale brown with lateral margins becoming almost white. Oral papillae white or nearly so.

Holotype, Australian Museum no. J 6043, from 25 miles southeast of Double Island Point, Queensland, 23 fms. Loaned by the Australian Museum.

A paratype from the same station is a trifle larger but not essentially different in any particular of either structure or color; for some reason, most of the large lowest arm-spines have been broken off near the base or distal to it. Another paratype dredged near Lindeman Island, Mackay, Queensland, in 1934 by Mr. Melbourne Ward, is a trifle smaller and is brighter colored, the banding of the arms being very conspicuous; the white margins of the upper arm-plates also show up well, while those of the under arm-plates are very conspicuous. The median part of each radial shield is cream-color and a line of this color connects it with the light margins of the basal upper arm-plates. In each interradial area at the margin of the disk and below, a light gray ground color is oddly variegated with cream-color and even the oral shields are variegated cream-color and gray. None of the lower arm-spines of this specimen are notably enlarged although they are the longest spines on the arm (fig. 30).

This is a very well-marked species differing from most of the other species of Ophiarachna in having naked radial shields. In this particular it resembles *O. robillardi* de Loriol of Mauritius and *O. quinquespina* Koehler. It differs from the former however in arm-spines and oral shields, and from the latter in the presence of supplementary oral shields and numerous pairs of arm-pores, not to mention the marked differences in coloration. It will not be easily confused with any other Australian brittle-star but it is remarkably similar to *Ophiarachnella macracantha* from the Caroline Islands.

PECTINURA ASSIMILIS

Ophiopeza assimilis BELL, 1888. Proc. Zool. Soc. London, p. 282.
Pectinura assimilis H. L. CLARK, 1909. Bull. M C. Z., **52**, p. 118.

This species is still unsatisfactorily known although it is apparently not rare in St. Vincent and Spencer Gulfs, South Australia. The 3 specimens at hand will not help any in adding to our knowledge. They range from 12 to 15 mm. in disk diameter but are in very poor condition and were probably picked up on some beach. Professor Bennett gave them to me at Perth and they are supposed to be from Western Australia, but confirmation of this supposed occurrence of *assimilis* on the western coast is greatly to be desired.

PECTINURA YOLDII

Ophiopeza yoldii LUTKEN, 1856. Vid. Med., p. 9.
Pectinura yoldii H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 119.

We did not meet with this well-marked species but Mr. Ward has sent two specimens from Lindeman Island, Queensland. The smaller is 12 mm. across the disk and has but 7 arm-spines on the largest arm-segments. The other is 15 mm. across the disk and has 9 arm-spines, which seems to be the maximum for the species, as specimens in the M. C. Z., 25–27 mm. in disk diameter have but 9 as a rule, 10 only here and there. The Lindeman Island specimens are light colored, the disks variegated with cream-color, light greenish brown and dusky; the arms are banded light gray brown and grayish-white, somewhat variegated with white, particularly on the darker bands; the whole lower surface is cream-color or dingy white.

PECTINURA NIGRA[1] sp. nov.

Disk relatively stout, more or less pentagonal, not notched for insertion of arms, 6.5 mm. in diameter; covered with a coat of fine granules, more than 100 to the square millimeter. Arms 25–30 mm. long, stout at base and slightly flattened there, tapering rapidly to a slender tip. Radial shields completely concealed. Upper arm-plates at base of arm, more than twice as wide as long, with smooth surface, straight proximal and distal margins, which are fully in contact, rounded distal angles and convex lateral margins; distally the plates become narrower, the proximal margin becomes rapidly shorter and shorter and so at the tip of the arms the plates are nearly, and at last completely, triangular and the last few are separated by the side arm-plates.

Interbrachial areas below small, granulated like disk. First under arm-plate much wider than long, elliptical with narrow ends; the next 2 or 3 plates are about as long as wide, somewhat hexagonal or octagonal, with distal angles wholly obliterated, the proximal less completely so; lateral margins slightly concave, proximal straight, distal flattened convex; succeeding plates increasingly longer than wide, more elliptical in shape, though the ends and sides are always a little flattened; near tip of arm where they are very small they are separated from each other by the side arm-plates. At base of arm, side arm-plates are about twice as high as their rather considerable width (length) but are confined to the sides of

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[1] *niger* = black, in reference to the unusual color.

the arm; distally they encroach more and more on the upper and under surfaces of the arm, and finally at tip of arm they meet broadly both above and below. Arm-spines 6; 5, 4 and 3 on the segments within the disk, and distally of course becoming similarly reduced; the spines are short, flat but thick, rather wide at base but bluntly pointed at tip; they are subequal or the uppermost is smallest, and are about half as long as the side arm-plate against which they lie. Tentacle-scales, 2, the inner longer than wide and somewhat longer than the outer more or less circular plate that overlies the base of the lowest arm-spine.

Oral shields relatively large, smooth, rounded triangular, with a wide inner angle and a convex distal side; length and breadth about equal, or the length possibly a trifle greater; madreporite scarcely larger than the others. Adoral plates very small, somewhat triangular closely appressed to the sides of the oral shields, proximal to distal angle. Surface of jaw closely covered with granules. Oral papillae 7 on each side, the next to the outermost, much the largest; it is wide and flat and bigger than the adoral plate; the others are narrow and more or less pointed.

Color in life, "nearly black;" the dried specimen is very dark dorsally but has a purplish cast; orally the color is lighter, particularly on the under arm-plates and arm-spines which are purplish-gray. The teeth are white and under the lens, the arms can be seen to become lighter distally and the very tip is white.

Holotype, M. C. Z., no. 5257, dredged in Koombana Bay, 5–8 fms., Bunbury, W. A. October 26, 1929.

This is a very well marked species in spite of its small size and aside from its unusual color — unusual that is for an Ophiodermatid. In my key to the species of Pectinura (1909, p. 116), it runs down at once to the New Zealand species *cylindrica* but the general facies is quite unlike that species and the arm-plates and arm-spines are as different as can be.

OPHIOCHASMA STELLATUM

Ophiarachna stellata LJUNGMAN, 1867. Öfv. Kongl. Vet.-Akad. Förh., **23**, p. 305.
Ophiochasma stellatum H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 121.

This handsome brittle-star is common around Broome but we did not find it at Cape Leveque, nor in the region of Darwin. Aside from a single large adult sent from Lindeman Island, Queensland (which by the way is a "farthest south" record for the species) all of the 53 specimens at hand were taken at Broome or between there and Wallal. They are a beautiful series ranging from 5 to 29 mm.

in disk-diameter and showing well the interesting growth changes through which the species passes. The 3 smallest have the disk pure white and the arms white with a half-a-dozen sharply defined cross-bands of gray-blue finely speckled with black. The oral shields are very long and narrow and lack supplementary shields. In fact these young Ophiochasmas are typical Ophiarachnellas! Adult specimens are pure white underneath and beautifully variegated with white, gray and light brown over the whole upper surface. This coloration matches remarkably the sandy bottom of Roebuck Bay.

OPHIARACHNELLA GORGONIA

Plate **15**, fig. 1

Ophiarachna gorgonia MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 105.
Ophiarachnella gorgonia H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 123.

This widespread Indo-Pacific species is very common at Broome, and was also found at Cape Leveque, but at Darwin only a few young individuals were secured. The series at hand ranges from 6 to 22 mm. in disk diameter but shows little diversity in coloration. The rather light colored disk usually has an irregular dark spot or blotch near center and this sometimes occupies a large part of the disk. The arms are always conspicuously banded with light and dark on the back and sides but the oral surface of the entire animal is unicolor, more or less nearly white. In young specimens at Darwin, there was in life a very evident pink shade on the disk and the arms were banded with pink and brown, but the colors faded rapidly after death and in the dry specimens only dusky and whitish or shades of brown and whitish remain.

The 38 specimens at hand are from the following places:

Northern Territory: Darwin, Three-and-a-half-Mile Reef, in a rock fragment, June, 1929. 1 specimen, very young.
Darwin, East Point, July 13, 1929. 1 specimen, young.
Darwin, near Leper Station, May, 1932. 1 specimen, small adult.
Western Australia: Augustus Island, October, 1933. Captain Beresford E. Bardwell leg. 1 specimen, small adult.
Cape Leveque, August, 1929. 2 specimens.
Broome, August and September, 1929. 19 specimens, adult and young.
Broome, June, 1932. 13 specimens, adult and young.

OPHIARACHNELLA INFERNALIS

Ophiarachna infernalis MÜLLER and TROSCHEL, 1842. Syst. Ast., p. 105.
Ophiarachnella infernalis H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 124.

This common East Indian species occurs along the entire northern coast of Australia from the Coburg Peninsula to Broome. How far west of the Broome region the range extends is still to be determined. The present series ranges from 5 to 16 mm. in disk diameter, the largest specimens being from Cape Leveque.

The 64 specimens at hand are from the following stations:

Northern Territory: Coburg Peninsula, Port Essington, Coral Bay, May 21, 1932. 1 specimen.
Darwin, East Point, under rocks, June, 1929. 3 specimens.
Darwin, near Shell Islands, 3–6 fms., July, 1929. 3 specimens, young.
Darwin, near Leper Station, 3–5 fms., May 25, 1932. 3 specimens, adult and young.
Western Australia: Augustus Island, October, 1933. Captain Beresford E. Bardwell leg. 2 specimens, adult and young.
Cape Leveque, August, 1929. 11 specimens, adult and young.
Broome, chiefly under rocks, August and September, 1929. 19 specimens. Adult and young.
Broome, chiefly dredged in 5–7 fms., June, 1932. 22 specimens, adult and young.

OPHIARACHNELLA RAMSAYI

Pectinura ramsayi BELL, 1888. Proc. Zool. Soc. London, p. 281.
Ophiarachnella ramsayi H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 305.

This species, closely allied to *gorgonia*, replaces it on the southern coast of Australia from New South Wales to North Beach, Fremantle, W. A. It grows to a much larger size than *gorgonia* and tends to distinctly brighter colors. The specimens at hand from New South Wales range from 5 to 31 mm. in diameter, while the 2 specimens from Western Australia are 31 and 35 mm. across; the latter has arms 190 mm. long. In color the New South Wales specimens show some diversity. The specimens from Bottle and Glass Rocks are very dark, those from Long Reef are lighter and more variegated and 2 of those from Shell

Harbor are very handsome with much rose-red in the coloration. When rose-red is present it tints the lower surface of the basal part of the arms, enters into the variegation of the disk and is indicated (and may be conspicuous) in the banding of the arms. The specimens from Port Jackson agree in the complete absence of bright tints; gray and dark gray form the color bands on the arms, while the disk and arm bases are dark, usually with an evident green tinge; the disk and upper arm-plates are usually faintly speckled or spotted with a darker shade; often there is a small irregular buff or yellowish spot on the disk and there may be several, but they are not conspicuous. There is one "recognition mark" shown by all specimens of *ramsayi* which I have examined (excepting only the two from Western Australia mentioned below) and that is the uniformly light colored (white, whitish or yellowish) lower surface of disk (mouth frames and basal portion of each interbrachial area) which is sharply marked off from the distal part of the same. Sometimes the boundary line runs across the interbrachial area midway between the oral shield and the margin, often it is more distal, and not rarely it is just below the actual margin of the disk. But it is always clear cut and in nearly all cases the contrast shown between the dark and light areas is striking.

The large specimens referred to above from Western Australia are notable for their color as well as their size. Were only the smaller one at hand, I should consider it an undescribed species but the larger one is so perfectly intermediate between it and the specimens from New South Wales, it will be enough to call it variety *pulchra* and thus attract attention to its striking coloration (Plate 14, fig. 1). The specimen is dry and hence the colors are probably less brilliant than in life; it is of course impossible to say whether they are essentially different. The disk is variegated with gray, yellow and rust color which are not sharply set off from each other but blend to a certain extent, with yellow as the predominant tint. The interbrachial areas below are distinctly yellowish and the oral shields and oral papillae are nearly orange. (All the plates about the mouth were stained with fluid from the stomach when the specimen was being dried.) The lower surface of the arms is uniformly light buff gradually becoming gray distally where the under arm-plates are finely speckled with dusky. The upper surface and sides of the arms are beautifully banded with orange yellow, bright brown and gray; the gray upper arm-plates show under the lens a fine speckling with blackish; the first 5 or 6 upper arm-plates on each arm are yellow, followed by one brown plate in marked contrast; then follow 6 or 7 gray plates, the most distal of which is brown at the outer corners, or the next succeeding plate may be brown proximally and become yellow distally. There are 3 or 4 more bands of yellow alternating with gray but beyond the middle of the arm the yellow is more and more marked with gray finely speckled with dusky, and distally there is no yellow the banding of the arm being very faint and caused by alternation of groups of speckled grayish plates with similar plates more definitely brown. The color of the arm-spines coincides to some extent with that of the plates which they adjoin. This beautiful specimen is no. 15058 in the Western Australian Museum and is of course the holotype of the variety.

The larger specimen is also in the Perth Museum and differs from typical *ramsayi* chiefly in the light colored disk, which is pale gray irregularly but definitely tinged with yellow, most marked near the disk margin. Orally the interbrachial areas are pale gray becoming nearly white near the oral shields, which with all the mouth frame and adjoining papillae are dingy white, as are the under arm-plates and the basal arm-spines. The first 3 or 4 upper arm-plates on each arm are distinctly yellow-brown showing a definite trend toward the yellow of the smaller specimen. The remainder of the arm however is banded light and dark gray like the Port Jackson specimens only the light gray is lighter and the banding is thus more noticeable.

The 18 specimens of *ramsayi* at hand are as follows:

New South Wales: Colloroy, Long Reef, November 28, 1929. 6 specimens; adult and young.
Port Jackson, near Middle Head, November 21, 1929. 1 specimen.
Port Jackson, Bottle and Glass Rocks, November 27, 1929. 5 specimens.
Shell Harbor, May 4, 1932. 4 specimens, adult and young.
Western Australia: about 10 miles north of Fremantle, North Beach, Triggs Island, 1 specimen, huge adult. Loaned by Western Australian Museum.
Rottnest Island, January, 1929. Mr. Horbury leg. et don. 1 specimen, adult. Holotype of variety *pulchra*. Loaned by Western Australian Museum.

OPHIARACHNELLA SEPTEMSPINOSA

Ophiarachna septemspinosa MÜLLER and TROSCHEL, 1842. Sys. Ast., p. 105.
Ophiarachnella septemspinosa H. L. CLARK, 1909. Bull. M. C. Z., **52**, p. 126.

We did not meet with this big ophiuran at any point where we collected, but Captain Bardwell found it at Augustus Island, W. A., in October, 1933 and sent 4 specimens, which are notable for their very dark color and large size. In the smallest specimen, 24 mm. across the disk, the bands on the arms are evident, though narrow and dim. In the largest individual, 36 mm. across, the color is very dark especially on the arms, and no bands are visible. In the other 2 specimens bands can be seen at the very tips of the arms. In all the specimens the arm-spines are unusually pointed and in no case is there any evidence of the supposedly "characteristic white tips."

OPHIARACHNELLA SIMILIS

Pectinura similis KOEHLER, 1905. "Siboga" Oph. Litt., p. 6.
Ophiarachnella similis H. L. CLARK, 1915a. Mem. M. C. Z., **25**, p. 306.

Among all the specimens of *O. infernalis* which I have collected, I have never seen one which answered in every particular to Koehler's description of his *similis*. In 1909, I asserted that the two were identical but in the face of my eminent French colleague's strong protest, I accepted *similis* as valid in 1915. In 1922 and again in 1930, Koehler insisted on the constant differences between the 2 forms but my scepticism has persisted. At last however, an Ophiarachnella is at hand, which is apparently an example of *similis* and I have examined it with keen interest. It was sent to me by Mr. Melbourne Ward who took it at Lindeman Island, on the Barrier Reef near Mackay, Queensland. It is 10 mm. across the disk and the arms are about 40 mm. long. The coloration is variegated gray and brown like *infernalis* but the arms are not so sharply banded, in this particular specimen. The disk granulation is a trifle coarser, the arms are more slender and the upper arm-plates are narrower. There are no naked plates in the interradial areas but the radial shields are not essentially different in size or form from those of *infernalis;* they seem somewhat thinner and flatter. On the lower surface the only noteworthy difference is that the oral shields are much smaller and the adoral plates are much bigger than in *infernalis*. In this comparison, specimens of *infernalis* from Darwin and Broome were used and the various differences were not hard to see, but when material from New Guinea or the Queensland coast was examined one or more of the differences failed to hold. I am therefore still in doubt as to the status of *similis* but hope that material from Lindeman Island or elsewhere on the Barrier Reef may finally settle the matter.

OPHIARACHNELLA PAUCIGRANULA[1] sp. nov.

Disk somewhat pentagonal, 7 mm. in diameter, very flat, covered with a coat of thin overlapping scales which, as always in the Ophiodermatidae, carry granules; these granules however are very minute and sparsely distributed; they are smallest and most numerous near the center of the disk, largest and most widely separated in the interradial areas at the disk margin; there may be more than 25 to the square millimeter where thickest, about 10 where most scattered. Radial shields relatively large, widely separated, a little longer than wide, quite bare. Arms 5, about 27 mm. long, distinctly flattened. Upper arm-plates with a finely shagreen-like surface; first one much wider than long, subsequent plates about as wide as long, the relative length increasing but little distally; near base of arm the plates are large, quadrilateral and broadly in contact, but the straight proximal margin is so much shorter than the strongly convex distal side, that the straight lateral margins are markedly divergent. Distally the plates decrease in size and in contact with each other so that near the arm-tip they are small and separated and perfectly triangular though the distal margin is still convex.

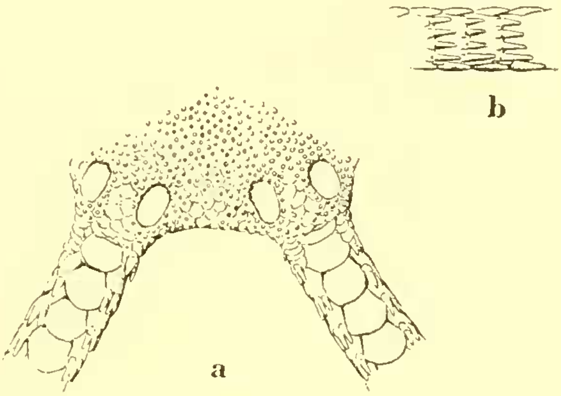

Fig. 31. Ophiarachnella paucigranula. x 6. a. Bases of 2 arms and adjoining portion of disk. b. Side view of 3 arm segments showing the arm-spines.

Interbrachial areas below covered with distinct thin scales bearing scattered minute granules. First under arm-plate twice as wide as long, rounded triangular; second and third plates somewhat wider than long, fourth and fifth about as wide as long, subsequent plates longer than wide; at first the plates are somewhat

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[1] *paucis* = few + *granula* = little grains, in reference to the remarkably sparse distribution of the granules on the disk.

hexagonal, with all distal angles rounded, and more or less in contact, but further out they become top-shaped and ultimately quite separated. Their surface is somewhat less shagreen-like than the upper plates. Arm-pores conspicuous, present far out on the arm. Arm-spines only 4, well spaced, the lowest much the longest and equalling the arm-segment, rather blunt; the other 3 are subequal and pointed. Tentacle-scales, as usual in the family, 2, the inner narrow, the outer broader, rounded or truncate at the tip which overlies the base of the lowest arm-spine.

Oral shields large, the madreporite not noticeably larger than the others, but its distal margin projects much more; each shield is a rounded triangle about as long as wide, the madreporite somewhat longer; distal margin slightly concave or straight; lateral margins convex and inner angle broadly rounded. A distinct supplementary plate adjoins each shield. Adoral plates very narrow, lying wholly along side of each shield, closely appressed; in some cases they extend down between the oral shield and arm-plates but quite as often they do not.

Color of dry holotype, interradial areas of disk both above and below, whitish or very pale brown; center of disk and a broad area in each radius, brown; radial shields somewhat lighter. Arms light gray with 4 broad, dark, almost blackish, bands, of which the first is at the very base of each arm; the bands completely encircle the arms.

Holotype, Australian Museum, no. J 6044, from "Magneta" Station XVII, Great Barrier Reef Expedition, off North Direction Island, Queensland, 19 fms. March 9, 1929.

This is an unusually well-marked species owing to the combination of a peculiar disk-covering with few well-spaced arm-spines. It is clearly an Ophiarachnella but quite unlike any previously known member of the genus.

OPHIARACHNELLA RUGOSA[1] sp. nov.

Disk nearly circular, 15 mm. across, considerably elevated, covered with numerous bare, swollen plates, separated from each other by lines and narrow areas of very fine granules (fig. 32); the largest of these plates are in a group of 3 lying between the distal ends of the large, naked, flat radial shields, which are at the very margin of the disk, at the base of the arm on each side. Other large swollen plates occur along the interradial margins and often near the inner ends of the radial shields; the smallest plates are near the center of the disk. Upper arm-plates a little swollen; the first 2 are low, twice as wide as long; succeeding plates are somewhat wider than long but distally the length and breadth are about equal; basally the plates have straight divergent sides; they are in contact the full length of the proximal side; distally they become more and more perfectly triangular and less and less in contact so that at the tip of the arm they are very small and well separated.

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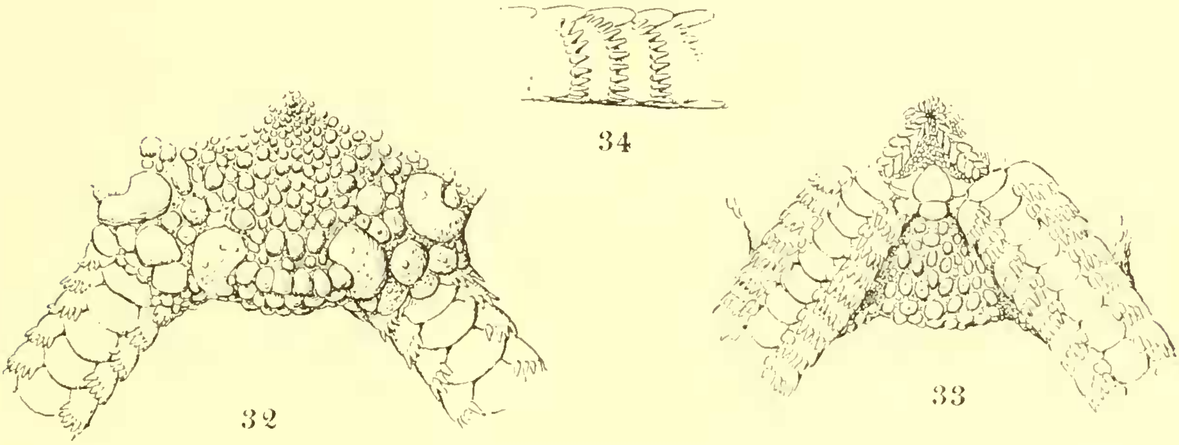
[1] *rugosus* = rough, rugged, in reference to the character of the disk.



Figs. 32–34. Ophiarachnella rugosa. x 4.
32. Bases of 2 arms and adjoining portion of disk.
33. Interradial area and bases of 2 adjoining arms.
34. Sideview of 3 arm-segments.

Interbrachial areas below (fig. 33) like disk, covered with bare, swollen plates surrounded by fine granules. First under arm-plates nearly twice as wide as long with strongly convex distal margin and rounded lateral angles. Second plate wider than long, with convex distal margin, the other three sides more or less concave; gradually the succeeding plates become longer than wide, more or less hexagonal, with a straight, short proximal margin and a convex distal edge, three times as long, with rounded lateral angles; distally the plates become small and widely separated. Arm-pores probably present but difficult to make out. Side arm-plates large, thick and projecting; distally they become fully in contact both above and below. Arm-spines 10 or 11 in a full series, short and peg-like, much less than $^{1}/_{2}$ the length of the side arm-plate (fig. 34), the 2 lowest longest and bluntest, the uppermost shortest and sharpest. Tentacle-scales as usual in the family, 2, the inner one narrow, the outer wider and more rounded, overlying the base of the lowest arm-spine.

Oral shields rounded triangular, about as long as wide, the distal margin concave, the lateral margins convex, and all angles broadly rounded. The madreporite is easily the largest. A large supplementary plate adjoins the distal side of each. Adoral plates rather large, more or less triangular, lying wholly at the sides of the oral shields, separating them from the first under arm-plate.

Color of dry holotype, disk light gray, speckled with a dark brown, or dusky; half a dozen of the spots are large enough to stand out somewhat, the largest more than a millimeter in diameter; on the smallest paratype there is one large circular dark spot at center of disk; in the next larger there are two, small but distinct spots and in the third there are 3 rather large and 2 small spots. Arms gray with 4–7 distinct bands of brown; the most nearly basal band is dark brown but the others are a yellow-brown often with dark brown at the proximal margins. Lower surface nearly white; distally on the arms are 2–4 shaded areas where brownish under arm-plates give a faint suggestion of arm-bands.

Holotype, M. C. Z., no. 5287, from Broome, W. A., 5–8 fms. June, 1932.

There are 3 paratypes, the smallest 6.5 mm. across the disk. They are surprisingly like the holotype save for their smaller size. This is a very distinct species, resembling *gorgonia* in some ways and *infernalis* in others. It is not very common at Broome for we did not find it in 1929 at all, and during all our collecting of June, 1932, we only secured 4 specimens.

CRYPTOPELTA CALLISTA[1] sp. nov.

Plate **14**, fig. 2

Disk circular, 10 mm. in diameter, flat, covered with a rather loose thin skin which becomes more or less wrinkled in dry specimens; this skin carries a dense coat of very fine granules, completely concealing the radial shields but not extending out onto the arms at all. Arms 5, hardly 40 mm. long, rather wide basally, much flattened, especially at tip. First upper arm-plate very low, nearly 3 times as wide as long; second plate nearly elliptical twice as wide as long; third plate wider than long, the straight proximal margin a little shorter than the convex distal side, so the straight lateral margins are somewhat divergent; succeeding plates similar but the distal margin increases in length and the lateral margins curve outward making conspicuous distal angles. Well out on the arm the plates become longer than wide, decrease much in size, are more and more triangular in form and separated by the side arm-plates; they finally become minute triangles and then wholly disappear.

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[1] κάλλιστος = *most beautiful*, in reference to its being the loveliest member of the genus.

Interbrachial areas below covered by the fine granulation of the disk, which also extends over the entire mouth frame, completely concealing the oral shields and adoral plates; a small circular spot on what is doubtless the madreporite, remains bare. First under arm-plates small but well defined, longer than wide, narrowest at the inner end; second plate larger and succeeding plates becoming hexagonal, as wide as long or wider, with definite proximal angles but distal angles a little rounded; in contact until very near tip of arm. Side arm-plates not conspicuous basally but at tip making up most of the arm. Arm-spines 7 or 8 in a series, peg-like, about half as long as the segment, sharp-pointed, lowest longest and uppermost smallest. Tentacle-scale single, moderately large, longer than wide, with rounded tip. Color of dry holotype, disk dull light yellow; arms white or pale gray with half a dozen broad bands of dark greenish gray; these bands completely encircle the arms. Lower surface of disk and mouth frame, light yellow. In life, the disk is bright orange, in sharp contrast to the conspicuously banded arms.

Holotype, M. C. Z., no. 5289, from Broome, W. A., 5–8 fms. June, 1932.

There are 8 paratypes of this notable and strikingly colored ophiuran at hand, of which our first specimens were taken at Cape Leveque in August, 1929, where we secured 2 individuals, one of which is more than 11 mm. across the disk and has arms more than 45 mm. long. A large and very brightly colored specimen was taken in Lagrange Bay in September, 1929, and a small individual, only 7 mm. across the disk, was found under a rock at Entrance Point the same month. The remaining 4 specimens were dredged in the Broome region in June, 1932. Aside from the striking coloration this species may be distinguished from its nearest ally, *C. granulifera* by the much stouter arms and thicker more peg-like arm-spines.

OPHIODYSCRITA[1] gen. nov.

Ophiodermatids with the granular covering of the disk extending out over the arms both above and below, as well as over the entire oral surface of disk and mouth frame. Tentacle-scales 2 or proximally, 3. Genital slits 2 in each interbrachial area.

Genotype, *Ophiodyscrita acosmeta* sp. nov.

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[1] *Ophio*, the common prefix for genera of ophiurans, +*δύσκριτος* = *hard to determine*, in reference to the uncertainty as to status of the specimen upon which the genus rests.

The single specimen upon which this proposed new genus and species is based, is probably immature and the possibility that it is the young of some previously known species must not be overlooked. But its characteristics are so well-marked and so different from any other known Australian brittle-star that they should not be ignored. The genus is obviously related to Ophioncus Ives and Ophiocryptus H. L. Clark but the presence of only 2 genital slits in each interbrachial area, the relatively long arms and delicate arm-spines on side arm-plates which project but little, and the complete granulation of all oral plates, even the madreporite, make a new genus necessary. It apparently bears the same relation to Ophiarachnella that Ophioncus and Ophiocryptus do to Ophioderma.

Ophiodyscrita acosmeta[1] sp. nov.

Disk pentagonal, 5 mm. in diameter, densely covered with a coat of very minute thorny granules; these cover not only the disk scales but the radial shields and extend out onto the arms. Arms 5, about 20 mm. long, flattened, wider than high. Upper arm-plates more or less completely hidden to the very tip of the arm by minute thorny granules like those which cover the disk but are possibly a little smaller; on the sixth and some subsequent arm-segments, a small elliptical bare area, usually distinctly wider than long, reveals a part of an upper arm-plate; these occur but rarely beyond the twelfth segment.

Interbrachial areas below and all of the surface of mouth frame and jaws closely covered with the fine granulation, save for a small circular spot on what is presumably the madreporite. (On one side of the mouth frame the granular coat has been accidentally rubbed off to some extent.) Under arm-plates on basal two-thirds of arm squarish with rounded corners, or more or less circular, well separated from each other by areas of minute granules which extend up on the basal, proximal side of each side arm-plate to unite with the granular covering of the upper surface of the arm. Under arm-plates become smaller and smaller distally and on the distal third of the arm are either wanting or concealed by the granular coat. Side arm-plates moderately projecting, each bearing 7 subequal, sharp, moderately slender arm-spines scarcely half as long as an arm-segment; here and there these little spines lie appressed to the arm but most of them project outward more or less markedly. Tentacle-scales 3 on the first few pores, the inner largest, the outer smallest; beyond the base of the arm there are but 2

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[1] ἀκόσμητος = *out of order*, in reference to the extension of granulation out to the arm-tips instead of its being confined to the disk as in nearly all other members of the family.

scales and distally these disappear, the outer one first; the scales are much longer than wide, somewhat pointed and hyaline in texture; on some arm-segments on the basal half of the arm, the outer scale tends to overlie the base of the lowest arm-spine but the arrangement is never so obvious as in Ophiarachnella.

Color of dry holotype, disk a very light fawn color which passes into white on the basal segments of each arm; remainder of arm occupied by alternating bands of dark purplish gray, occupying about 2 segments, and pale gray or whitish, occupying 3 segments; the arm-spines are the same color as the segments on which they are borne; lower surface more or less nearly white, except for the dark bands on the arms, which are encircling; the granules on the surface of the jaws are distinctly greenish-yellow, but very light.

Holotype, M. C. Z., no. 5294, dredged at Broome, W. A., June, 1932.

This remarkable little brittle-star was supposed to be a young Ophiarachnella when taken and no attention was paid to it, so there is no available information about its habitat or even the exact place where it was collected. Obviously it cannot be at all common.

OPHIOLEPIDIDAE

Ophiomisidium flabellum

Ophiomusium flabellum Lyman, 1878. Bull. M. C. Z., **5**, p. 120.
Ophiomisidium flabellum Koehler, 1914. Bull. **84** U. S. N. M., p. 32.

There are at hand half a dozen specimens of this odd little brittle-star from the following stations. All were loaned by the Australian Museum:

New South Wales: Off Botany, 2.5–4 miles, 37–56 fms. Trawler "Goonambie." McNeil and Livingstone leg. 2 specimens.
Off Botany Bay, 50–52 fms. "Thetis" Expedition. 2 specimens, adult and young.
15 miles northeast of South Head, Port Jackson, 75–80 fms. May, 1924. C. W. Mulvey don. 2 specimens, young and small adult.

Haplophiura gymnopora

Ophiozona gymnopora H. L. Clark, 1909a. Mem. Austr. Mus., **4**, p. 535.
Haplophiura gymnopora Matsumoto, 1915. Proc. Acad. Nat. Sci. Phila., **67**, p. 76.

This little brittle-star appears to be common off Botany Bay for there is a large series at hand from that region. The largest is only 4.5 mm. across the disk but this is much larger than any other specimen; 2–3 mm. in disk diameter is the usual size; the arms rarely exceed 5 mm. Only two stations are represented in the present material, all of which was loaned by the Australian Museum.

Off Botany Bay, N. S. W.; 50–52 fms. "Thetis" collection but not hitherto identified. 52 specimens.

Off Botany, N. S. W.; 2.5–4 miles, 33–56 fms. Trawler "Goonambie." McNeil and Livingstone leg. 3 specimens.

AMPHIOPHIURA CTENOPHORA

Ophiura ctenophora H. L. Clark, 1909a. Mem. Austr. Mus., **4**, p. 537.
Amphiophiura ctenophora H. L. Clark, 1915a. Mem. M. C. Z., **25**, p. 310.

Along with the specimens of *Ophiura oöplax* taken in 120 fms., some 22 miles off the Port Jackson Heads, Captain Moller took a small ophiuran, about 5 mm. across the disk, which has been kindly loaned by the Australian Museum. Apparently this is a young individual of *A. ctenophora*. There are some noticeable differences in the under arm-plates and tentacle-pores and scales, on the basal arm-segments, but they are probably to be accounted for by the youthfulness of the present specimen.

OPHIURA KINBERGI

Ljungman, 1866. Öfv. Kongl. Vet.-Akad. Förh., **23**, p. 166.

A single specimen of this common East Indian brittle-star, which ranges from Japan to South Australia, was taken by us when dredging off Middle Head, Port Jackson, in 4–6 fms., November 21, 1929. It is a full 10 mm. across the disk, a little larger than any in the M. C. Z. collection; I find no published record of a bigger individual. But Koehler gives no data as to the size of the scores of specimens he has examined. Besides its large size the present specimen is notable for its short arms; all are broken at the extreme tip but if complete they could scarcely have exceeded 20 mm.

While dredging in Lagrange Bay, W. A., in September, 1929, we took 4 small ophiurans (3–4 mm. across disk) which seemed to be the young of *kinbergi*. In June, 1932, we met with the same thing at various points in Roebuck Bay and southwestward, and 33 specimens are at hand, the largest scarcely 5 mm. across the disk. Compared with adult *kinbergi* (8–9 mm. in disk diameter), these small individuals from the northwestern coast show notable differences particularly in the upper arm-plates, but after comparison with material from Japan and the

Philippines which includes specimens little more than 5 mm. across the disk, no constant distinctions are found. In general it may be said that the arms are more conspicuously constricted at the joints, the upper arm-plates are smaller, more triangular and more swollen, and the coloration brighter in the Broome material. Many specimens have the arms conspicuously banded and notable dark spots on the disk at the inner end of the radial shields. It is odd that no adult *kinbergi* were taken on the northwestern coast.

OPHIURA OÖPLAX

Ophiocten oöplax H. L. CLARK, 1911. Bull. **75** U. S. N. M., p. 99.
Ophiura oöplax MATSUMOTO, 1915. Proc. Acad. Nat. Sci. Phila., **67**, p. 81.

Although originally described from material taken in Japanese waters, in 1928 I reported specimens from South Australia and two years later Koehler (1930, p. 223) recorded others from New South Wales. It is not surprising therefore that Captain K. Moller took half a dozen specimens 22 miles east of Port Jackson Heads in 120 fms. These have been loaned by the Australian Museum and I have compared them with Japanese material. The only noteworthy difference is that the Australian specimens have the disk flat and pentagonal while those from Japan have it more or less circular and distinctly less flattened.

DICTENOPHIURA STELLATA

Ophioglypha stellata STUDER, 1882. Gazelle Oph., p. 11.
Dictenophiura stellata H. L. CLARK, 1923a. Ann. S. Afr. Mus., **13**, p. 361.

This is one of the common sea-stars of the Broome region. The type locality is Mermaid Strait, west of Cossacks, W. A. Studer's statement that it was taken at "Ausgang der Naturaliste Channal (West-Australien)" is evidently a slip. The 103 specimens range from 2 to 11 mm. across the disk and show an excellent series of growth stages. One specimen 6 mm. across disk is perfectly tetramerous. In life the upper surface, prettily variegated with shades of gray and sometimes brown, harmonizes perfectly with the sand in which the ophiuran lives, just below the surface. The under side of *stellata* is pure white. All the material was dredged in shallow water (5–8 fms.); 58 specimens were secured at Broome in 1929 and 36 in 1932. The remaining 9 specimens were taken by Captain Bardwell in October, 1933, in the vicinity of Augustus and Champagay Islands, W. A.

OPHIOTEICHUS[1] gen. nov.

Ophiolepidids having the disk scales more or less swollen and surrounded by belts of very small flat plates, with the marginal plates of the interradii greatly swollen and forming a low rampart around the disk. No supplementary upper arm-plates, but a series of small pores occurs between the lateral margins of mature upper arm-plates and the adjoining side arm-plates. Tentacle scales 2, as in Ophiolepis, and lower surface of arms much as in that genus but arm-bases not conspicuously widened.

Genotype, *Ophioteichus parvispinum* sp. nov.[2]

This extraordinary new genus is another example of the surprising diversity and fascinating uniquity of the Australian fauna. Seen from the oral side these brittle-stars would pass for Ophiolepis but the aboral surface is so dominated by the swollen marginal plates that a new genus is obviously needed for their reception. That two quite distinct species should occur on the eastern coast of Australia and neither have been seen before 1932 is remarkable enough but that each is as yet known from but a single specimen adds to the interest of the discovery.

OPHIOTEICHUS MULTISPINUM[3] sp. nov.

Plate 25, fig. 5

Disk more or less circular, about 15 mm. in diameter, covered with a coat of numerous small, swollen, smooth plates, among which the 6 primary plates form a compact but not conspicuous group at the center; many of the plates are more than merely swollen, they culminate in low blunt or truncate tubercles; each plate is surrounded by a belt of very small flat plates. Radial shields small but larger than the primary plates, smooth, flat, widely separated by 2 or more disk plates. At the margin of the disk, radially, just distal to the radial shields are a few small plates, of which 2 carry each, a conspicuous blunt tubercle a half a millimeter or more in diameter and about the same in height; the 2 tubercles stand closely side by side at the margin of the disk more or less obscuring the very low and wide first 2 upper arm-plates. In each interradius the disk margin is formed by 3 huge swollen plates, 1.5–2 mm. in diameter and nearly as high; the 3

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[1] *Ophio,* the common prefix for ophiuran genera + τεῖχος (neuter) = *a wall around a city,,* in reference to the ramparts raised around the disk by the huge marginal plates.

[2] This species is selected as the type, because it was collected 2 years before the larger species.

[3] *multus* = many + *spinus* = spine, in reference to the large number of arm-spines.

lie closely side by side, the lateral ones crowded against the radial shields. Arms 5, notably flattened, about 25 mm. long and nearly 3 mm. wide at base, tapering gradually to a blunt tip. First clearly formed upper arm-plate is quadrilateral, much wider than long, with the proximal margin straight and considerably shorter than the convex distal edge; hence the short straight sides of the plate are divergent; distal corners rounded. Succeeding plates similar but increasingly longer and more triangular, in contact by the width of the proximal margin; the distal margin becomes straighter and noticeably swollen and the distal corners more acute. Along each lateral margin a series of half a dozen minute pores becomes rather noticeable between the upper arm-plate and the side arm-plate; under sufficient magnification it can be seen that these pores occur on all (?) the segments of the arm back to the disk but apparently they disappear with increasing age and they are difficult to make out on the basal quarter of the arm; it is difficult to guess what the function of such pores may be. At the very tip of the arm, the minute triangular upper arm-plates are widely separated by the contact of the side arm-plates.

Interbrachial areas below covered with plates like those of the disk but less swollen, becoming smaller and flatter as the oral shield is approached, but the surrounding belts of minute flat plates are present very nearly to the shield. Genital slits one on each side, very long, extending from oral shield nearly to disk margin. First under arm-plate low and wide, rounded laterally; succeeding plates quadrilateral becoming bell-shaped; at first wider than long but soon the length exceeds the width; lateral margins more or less deeply concave because of the large tentacle-pores at each side; broadly in contact at first, the plates become separated by the side arm-plates near the tip of the arm where they have become very small and triangular. Side arm-plates large and projecting; each plate carries a crowded vertical series of arm-spines; these spines are so delicate and so crowded, they are very difficult to count accurately; on the basal part of the arm, there are a dozen or more in each series, the upper ones longest, equalling the arm-segment, the lowest shortest, only half as long as the upper ones; all are very flat and fragile looking, pointed, wide and overlapping laterally; they thus conceal most of the side arm-plate, as seen from above. Tentacle-scales 2, flat and sub-equal closing the large pore as in Ophiolepis.

Oral shields longer than wide, excepting the madreporite in which length and breadth are nearly equal; each shield is distally rounded and proximally has a long acuminate point with slightly concave sides. Adoral plates relatively very large, about 4x as long as wide, meeting at the bluntly pointed inner ends, widened distally and broadly separating the oral shield from the side arm-plates. Oral plates large and somewhat swollen. Oral papillae 6 on each side, the penultimate much the largest, as wide as the third and fourth together; distalmost plate narrow, long triangular extending forward beneath (as seen with the animal upside down, of course) the big fifth plate. The mouth slits are tightly closed in this specimen.

Color of dry holotype, pale purplish-brown, the big marginal plates lighter; the arms have 4–6 narrow light bands but they are rather inconspicuous and ill-defined. Lower surface nearly white but many under arm-plates have a dull reddish tinge.

Holotype, M. C. Z., no. 5306, from "under dead coral," Lindeman Island, Great Barrier Reef, near Mackay, Queensland. July, 1934. Melbourne Ward leg. et don.

This remarkable ophiuran ranks as one of Mr. Ward's most notable discoveries at Lindeman Island. When first seen, it was supposed to be a large specimen of the following species from Lord Howe Island but one glance with the lens revealed the extraordinary arm-spines and settled its status as an important novelty.

OPHIOTEICHUS PARVISPINUM[1] sp. nov.

Plates **15**, fig. 2; **25**, fig. 4

Disk more or less circular, 6 mm. across. Arms 5, short, flattened, little widened at base, 11 mm. long. Disk covered with a coat of relatively coarse somewhat swollen smooth plates among which the 6 (as it happens there are 7 in this specimen) primary plates are largest; each plate is surrounded as in Ophiolepis by a belt of small, thin, flat plates. Radial shields small, flat, not as large as one of the central group of primary plates; the two shields of each pair are separated from each other by one or more small plates in a radial series; at the distal end this series expands to a group of 2 or 3 plates abutting on the first upper arm-plate, and one of these either bears a tubercle or is itself conspicuously swollen. In each of the interradii the disk margin is completely occupied by 3 (in one case 4) very conspicuous swollen plates; in the interradius with 4 such plates, and in one of the others, the outer plate on one side crowds over onto a radial shield; these swollen plates are .50–.75 mm. in diameter. First 2 or 3 upper arm-plates very low and wide, closely crowded together, followed by a wide

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[1] *parvus* = small + *spinus* = spine, in reference to the minute arm-spines.

plate half as long as wide; succeeding plates much narrower becoming more and more triangular, much smaller and less in contact; on the distal half of the arm they are small, about as long as wide, perfectly triangular and widely separated. There are no supplementary upper arm-plates of any sort, but there are minute pores (usually 4 or 3) along the lateral margins of each upper arm-plate, between it and the adjoining side arm-plates; these pores are wanting on the first segment or two and on the distal third of the arm.

Interbrachial areas below covered by plates like those of the disk but smaller, flatter and less regularly surrounded by belts of minute plates; the latter are quite wanting near the oral shields. Genital slits single on each side of the area, rather long, extending from oral shield nearly to disk margin. Under arm-plates, well developed, bell-shaped with deeply concave lateral margins, a very slightly convex distal edge and a narrow proximal end in contact with the preceding plate; on the distal half of the arm, the plates become small, somewhat triangular and widely separated. The arms are widest at about the eighth segment, but they are not conspicuously widened even there. Side arm-plates relatively very large and moderately projecting; beyond the middle of the arm they meet broadly both above and below. Arm-spines 4 (very rarely 5) very short, thick at base but pointed at tip; they are crowded close together near the middle of the edge of the side arm-plate, the lowest longest and biggest, the uppermost smallest; even the lowest is little more than a third of the length of the arm-segment. Tentacle pores large and closed by 2 flat, nearly equal, well matched plates as in Ophiolepis.

Oral shields small, the madreporite not noticeably bigger than the other, distal and lateral margins rounded; they look wider than long but as the proximal angle projects inward markedly it is probable that length and width are about equal. Adoral plates long and narrow, lying wholly proximal to the oral shield and meeting fully within; distally there is a thin projection which separates the oral shield and the first under arm-plate. Oral plates well developed but not so large as the adorals. Oral papillae 6 on each side, the penultimate much the largest, wider than the third and fourth together; the outermost is narrow, a little swollen basally and projects forward under (or over, really, of course) the broad penultimate.

Color in life, disk pearl gray with the big marginal plates white; arms white with 2, 3 or 4 narrow bands of bright yellow brown. The dry specimen is nearly all white but the disk has a faint gray tint and the bands on the arms are pale reddish brown and ill-defined.

Holotype, M. C. Z., no. 5307, from Neds Beach, Lord Howe Island. April 16, 1932.

My field notes tell the story of finding this extraordinary brittle-star, as follows:

"Under a stone on Neds Beach reef-flat, Livingstone found (just as we were leaving) a superb ophiuran quite unknown to us; apparently a new genus. The circular pale gray disk was noticeably elevated or puffed and 3 white swollen plates limit each interradius." Repeated and prolonged searching failed to uncover another specimen. Livingstone said he turned over the rock fragment which was lying on clear sand well above low water mark and not seeing any animal life he began sifting the underlying sand through his fingers. To his surprise this little brittle-star remained in his hand!

The differences between this species and the preceding are not numerous but are very striking, the most important being in the arm-spines; it is rare that such totally different arm-spines occur within the limits of a single genus. The presence of a tubercle or swollen plate between the distal ends of the radial shields instead of the conspicuous pair of knobs seen in *multispinum* is a second noteworthy character. Other differences may be due in large part to the considerably greater size of the Queensland specimen.

OPHIOLEPIS UNICOLOR[1] sp. nov.

Plate 25, fig. 2

Disk 26 mm. in diameter. Arms 5, 75–80 mm. long. In form and all structural features like the well known *O. superba* H. L. C. but of a uniform red-brown, orange-brown or dark olive brown color without spots or markings of any kind. The color is little altered by preservation and dry specimens look much the same as they did in life eight years ago.

Holotype, M. C. Z., no. 5308, from under a rock at Entrance Point, Broome, W. A. August, 1929.

This interesting but inert brittle-star is not rare at Broome, but it is by no means common. In 1929, 5 specimens were secured but in 1932, when very little shore collecting was done, only 2 were found. It was never dredged. Michaelsen and Hartmeyer took a specimen at Turtle Island, northwestern Australia, in 1905, which Koehler (1907, p. 243) records as "*Ophiolepis annulosa* Müller and Troschel" (=*superba* H. L. C.). But he says that the color is "un brun chocolat clair uniforme sans trace d'annulations sur les bras." Whether the particular shade of brown in this specimen is natural or caused by the means of preservation, there is no means of telling now, but it is interesting to note that a specimen at hand, taken by Captain Bardwell at Augustus Island, in October, 1933, is of a deep olive-brown with the dry tentacles perfectly black. It seems to me probable that this very dark color is at least to some extent artificial. But it is interesting that the darkest colored individuals (assuming that the shades are not artificial) were secured at the western and eastern extremes of the present known range. There are specimens of *superba* in the M. C. Z. with the dark spots on the disk very small and rings on the arms few and narrow, but the markings are always more or less conspicuous, and the ground color is a yellow brown or buff. It is interesting to note that typical *superba* is known from Darwin and the coast of the northern Territory.

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[1] *unicolor* = of one color, in obvious reference to the specific character.

OPHIOPLOCUS IMBRICATUS

Ophiolepis imbricata MÜLLER and TROSCHEL, 1842. Sys. Ast., p. 93.
Ophioplocus imbricatus LYMAN, 1861. Proc. Boston Soc. Nat. Hist., 8, p. 76.

This common Indo-Pacific ophiuran may be expected anywhere on the tropical coasts of Australia. We found it at Lord Howe and from there it ranges via Torres Strait and Darwin to the Broome region and even to Shark Bay and the Abrolhos. The specimens from Lord Howe have the light sandy coloration shown by many individuals at the northern end of the Barrier Reef (See H. L. Clark, 1921, p. 143; pl. 12, fig. 8) and I have been inclined to give them a varietal name. But all efforts to find constant tangible characters have proved fruitless.

In the lot of specimens sent by Captain Bardwell from Augustus Island are 3 distinct color varieties and one is curious to know whether they were actually taken together or came from three different areas. Besides the ordinary gray form, there are 2 specimens with the disk tinted with orange above and strongly orange or red-orange on the lower surface, particularly near the oral shields; 3 other specimens have light brown disks with an orange-red tint on the lower surface. This form is not matched by anything in the M. C. Z. collection. Then there are 2 specimens, both young (7–11 mm. across the disk) which are distinctly violet, unlike any Ophioplocus at hand. There is however good ground for suspicion that this tint is artificial for an *Ophiarachnella infernalis* from Augustus Island shows the same tint. Probably these specimens were accidentally stained either by the preserving fluid or the container, but it is desirable to mention the specimens in case violet colored individuals should be taken elsewhere.

Specimens from Darwin, Quail Island, Cape Leveque and Broome, all have the general coloration light; the arms are light gray conspicuously banded with darker. The specimens from Augustus Island are notably darker, the arms being a dusky olive or olive gray, with darker bands.

The 39 specimens of Ophioplocus at hand are from the following places:

Lord Howe Island: April, 1932. 6 specimens.
Northern Territory: Darwin, beaches at East Point and eastward, June and July, 1929. 5 specimens.
Quail Island, west of Darwin, July, 1929. 2 specimens.
Western Australia: Augustus, and Champagay Islands, October, 1933. Captain B. E. Bardwell leg. 15 specimens, adult and young.
Cape Leveque, August, 1929. 2 specimens.
Broome, Entrance Point, August, 1929. 4 specimens, adult and young.
Broome, Gantheaume Point, June, 1932. 5 specimens, adult and young.

ECHINOIDEA

The collection of Echini contains 1,284 specimens, representing 45 genera, 71 species and 5 varieties. Of the genera, one, HESPERASTER, is new, a most important link between Clypeaster and Arachnoides. Of the species 11 are new, as are three of the 5 varieties. The new species are as follows:—

Asthenosoma intermedium	Q., Lindeman I.
Temnotrema notium	W. A., Albany.
Pseudechinus hesperus	W.A., Rottnest Island.
Hesperaster arachnoides	W.A., off Fremantle.
Hesperaster crassus	W.A., Rottnest Island.
Arachnoides tenuis	W.A., Broome.
Echinocyamus planissimus	W.A., Broome.
Apatopygus occidentalis	W.A., off Fremantle.
Hypselaster dolosus	W.A., Broome.
Rhynobrissus macropetalus	W.A., Broome.
Eupatagus dyscritus	Victoria?

The new varieties are:

Prionocidaris bispinosa var. *laevis*	W.A., near Fremantle.
Temnopleurus michaelseni var. *viridis*	W.A., exact locality?
Heliocidaris erythrogramma var. *parvispina*	W.A., Point Peron.

Echini are common on all parts of the Australian coast where conditions are satisfactory,—clean, well-aerated salt water being an essential factor. The number of species, however, is small at any one locality, though the number of individuals may be surprisingly large. From Broome 24 species are listed, but of these there are three which we did not take in our collecting in either 1929 or 1932; and of two others, one specimen of each was taken in 1929 but not in 1932. An echinoid fauna of 20 species may therefore be considered a rich one, even for tropical Australia. On the other hand, many species, if they occur at all, are found in great abundance. In some cases, such as the clypeastroids and spatangoids which live more or less buried in the sand or mud, this abundance is revealed only by the dead tests washed up by scores, hundreds or even thousands along the beaches. In other cases, such as the rock-loving urchins, Heliocidaris and Echinometra, thousands of individuals will be found on suitable reef-flats or scattered among the corals and rock fragments upon or near the reefs.

Of the 71 species in the present collection, some 27 have been recorded at some time from the Queensland coast and make up the Barrier Reef echinoid fauna, while an equal number characterize the northwest coast, a dozen species being common to both coasts. Western Australia, south of Northwest Cape, has an echinoid fauna of at least 20 species, of which three-fourths do not occur on the northwest coast, and only four or five are found on the Queensland coast. On the coasts of southern Australia and Tasmania, about 25 species of echini occur and only some half dozen of these occur also on the Western Australian coast. The shores of New South Wales harbor but few echini, for although Whitelegge (1889) lists 29 species for Port Jackson and neighborhood, many of the names cannot be trusted; for example, there are not more than two species of Salmacis (or at most, three) to be found on the coasts of southeastern Australia, whereas Whitelegge lists six. Apparently not more than 20 echini are actually known from along shore in New South Wales. At Lord Howe Island, we found but 11 species and of these 5 do not occur in Whitelegge's Port Jackson list and two others are tropical species, of doubtful occurrence on the New South Wales coast.

The literature dealing with Australian echini is rather extensive, beginning with the "Revision of the Echini" (1872–74) in which fundamental work Alexander Agassiz listed from the Australian district 44 species. Of these, 7 are no longer regarded as valid and three occur only in New Zealand. In 1872 then, there were 34 species of echini known from Australia. From 1878 to 1889, there was considerable activity in this field of research and Bell, Ramsay, Tenison-Woods and Whitelegge each published one or more papers dealing with Australian echini. Reports on the echinoderms collected by the "Thetis" and later by the "Endeavour" were published by me in 1909 and 1916 and other papers in which Australian echini are discussed by me appeared in 1914, 1921, 1923 and 1928. Döderlein's report (1914) on the echini brought from Western Australia by Michaelsen and Hartmeyer, and Mortensen's paper (1918) dealing with those collected by Mjöberg on the northwestern coast, are important papers, which have been of great value in preparing the present report. The number of Recent echini now known from Australia apparently approaches 100.

My good friend, Dr. Th. Mortensen of Copenhagen, has kindly given me much assistance in my study of the material in hand. He generously permitted me to send him puzzling specimens and has freely discussed the questions that I have put to him. Since, in his knowledge of Recent echini, he is *facile princeps*, the help he has been able to give me is very great. It is therefore a pleasure to express here my debt to him and to thank him heartily for his invaluable assistance.

In collecting echini, the handling of the specimens gives no trouble. If they are placed at once in alcohol, satisfactory specimens are almost sure to result. Formalin, by itself, is undesirable and gives mediocre or poor specimens. My best specimens have resulted from killing the animal in fresh water and then transferring to a week formalin solution, containing corrosive sublimate ($HgCl_2$). After a thorough soaking in this, they were dried as rapidly as possible in the shade. Too much corrosive sublimate must be avoided as it tends to leave a coating on the dry specimen. Direct sunlight, of course, tends to fade the colors. Dr. Robert T. Jackson, the eminent student of echini, has prepared the finest specimens I have ever seen, by saturating in a very weak solution of corrosive sublimate (1 part to a thousand) and then drying rapidly. He has published a detailed account of his method (1930, Museums Journal, **29**, pp. 385, 386) which should be consulted. Experience has led me to believe that in wet weather or whenever the specimens cannot be dried rapidly, the solution should be stronger than recommended by Jackson, and my results have been better when I have used a little formalin therein.

CIDARIDAE

GONIOCIDARIS TUBARIA

Cidarites tubaria LAMARCK, 1816. Anim. s. Vert., **3**, p. 57.
Goniocidaris tubaria LÜTKEN, 1864. Bidr. Kundsk. Ech., p. 137.

This very common sea-urchin is represented in the present collection by only a few young specimens. Mortensen (1928, p. 161) has pointed out that the name *tubaria* should be used for this species and not *geranioides* as I proposed in the British Museum Catalogue (1925, p. 31). Lamarck's *geranioides* is not merely unidentifiable, as Mortensen says, but it is certainly not one of the Cidaridae at all, as the figures to which reference is given show very conspicuously the gills which members of this family lack. Consequently, if the name *geranioides* is to be used, it cannot be for a cidarid.

The half dozen specimens of *tubaria* at hand come from the following places. It is worthy of note that the species has not yet been found at Lord Howe Island.

South Australia: Port Willunga. W. J. Kimber leg. et don. 3 small specimens, 1 very young and bare.
Western Australia: Bunbury, in Koombana Bay, 5–8 fms., October 26, 1929. 1 half grown specimen.
Bunbury, in beach drift, September 28, 1930. E. W. Bennett leg. et don. 2 young specimens.

PRIONOCIDARIS AUSTRALIS

Phyllacanthus australis RAMSAY, 1885. Cat. Ech. Austral. Mus., p. 44.
Prionocidaris australis H. L. CLARK, 1916. "Endeavour" Ech., p. 97.

Although this fine cidarid has already been reported from Lord Howe Island by Mortensen (1928, p. 459), the specimen which we took there on the reef near Mt. Lidgbird, April 19, 1932, is of more than usual interest, for it is the smallest *australis* that has as yet been recorded, and seems to prove conclusively that the East Indian *Prionocidaris glandulosa* (de Meijere) is, as Mortensen (1928, p. 460) claims, a perfectly distinct species, of which the adults are apparently not yet known.

The specimen of *australis* which we took at Lord Howe was the only cidarid we found in three weeks of collecting. It is 26 mm. in diameter and about 16 mm. in height; the diameter of the abactinal system is 11–12 mm. and that of the oral system is less, but exact measurements cannot be given without damaging the specimen, which hardly seems worth while in this case. The primary spines are conspicuously large, wide and flattened and blunt or even truncate at tip; the largest are 35–37 mm. long and 4–5 mm. wide. They are relatively stouter than in adult specimens; hence they are as different as can be from the spines of *glandulosa*. My field notes on this specimen are as follows: "Noticeably handsome with secondaries and abactinal spines very bright garnet red, brilliant in sunshine. Larger primaries very thorny, light brown where clean but appearing deep gray with a reddish cast from dirt or some sort of fine growth on the spine; collar a darker red-brown with white spots." The dried specimen has lost its brilliance but the color is not essentially changed. It is evident now, of course, that the "some sort of fine growth" on the primaries is the coat of anastomosing cortical hairs normal to the mature spines of Prionocidaris.

The first record of a cidarid from Lord Howe is that of Etheridge (1889, p. 37) who says that while his party did not take a specimen, a broken one was presented by Mr. Campbell Stevens, and he says it is "a Phyllacanthus, perhaps *P. baculosa* Lam'k." This specimen is in the Australian Museum now and is a badly damaged *Prionocidaris australis.*

PRIONOCIDARIS BISPINOSA

Cidarites bispinosa LAMARCK, 1816. Anim. s. Vert., **3**, p. 57.
Prionocidaris bispinosa DÖDERLEIN, 1911. Abh. Senck. Nat. Ges., **34**, p. 240.

This is a very common sea-urchin at Broome but we did not meet with it at Darwin. While it is probably correct to say that no two of the Broome specimens are exactly alike and there is a considerable range in the length, diameter and thorniness of the spines, as well as in the color of the secondaries, on the whole the diversity is not extreme and no one would hesitate to call them all a single species. Young and half-grown specimens are as a rule light colored, often very light cream-color with or without a tinge of red, and large ones are dark, often dark reddish-brown but quite as often a greenish or grayish brown. Oddly enough, not one specimen seems near to Mortensen's variety "*elegans*" which was taken in the southwestern part of the Broome region. On the other hand no specimen approaches at all closely the variety *nigro-brunnea* Mortensen from Shark Bay. In size, the specimens from Broome range from young ones scarcely 4 mm. in diameter, with primary spines 5 mm. long, to obviously old specimens 50 mm. in diameter; the primary spines of these old specimens show great diversity but are generally considerably less than 50 mm. long and sometimes are scarcely 30 mm. Half-grown specimens often have the primaries 30–80% longer than the test diameter.

The specimens which Captain Bardwell met with near Augustus Island are very different from anything seen at Broome and prove to be extreme examples of the variety *aruana* Döderlein. They range from 17 to 23 mm. in diameter, and the slender, terete primaries are 58–68 mm. long and 2.5–4 mm. in diameter; of at least one spine on each specimen (and often more), the tip is expanded but not greatly so. The upper primaries are whitish or yellowish more or less banded as usual with purplish-red: the old ones in the midzone are gray; the collar on the younger primaries is a pinkish-lavender but becomes paler and duller on the older ones; the test is yellow; the secondary spines are whitish, each with a longitudinal pale brown stripe. On the whole, in this extreme form, the variety *aruana* seems to be one of the most easily recognized of the numerous varieties of this protean species.

Among the echinoderms given me by Professor Bennett in 1929, is a very handsome Prionocidaris which I believe to be an extreme variety of *bispinosa*. As it is labelled "Garden Island, April 25, 1914," it comes from far south of the known range of the species and if its characters prove constant, it may well be given specific rank. Until more material is available I propose to call it *Prionocidaris bispinosa* var. *laevis*. The unique holotype (M.C.Z. no. 7075) is 56 x 31 mm. in diameter and height (Pl. 26, fig. 1). The largest primaries are 65–70 mm. long, more or less fusiform, 5–6 mm. in diameter 8–10 mm. from the base; they are usually encrusted with a whitish bryozoan for much of their length; the collar is about 5 mm. high, of a greenish-yellow color, more or less brownish distally; young spines and many large ones are banded with purplish-red, as usual. The fourth and fifth spines in each series, counting up from the mouth, are attached below the ambitus and are notable for their widely expanded tips, as much as 5 mm. in diameter. All of the spines, young and old, are free from thorns and appear smooth to the unaided eye; there are really, however, some 25 or more longitudinal, parallel, rather crowded series of granules of nearly uniform size, which make the surface of the spine rough to the touch. Most of the primaries are relatively clean and free from foreign organisms but the oldest are more or less covered by bryozoa and occasionally a low barnacle or worm-tube is present. The interambulacral secondaries are dirty whitish with a longitudinal stripe of light brown not very sharply defined; the ambulacral secondaries, the miliaries and the test are more or less dark red-brown. On some primaries the collar, as well as the neck, has one or more crimson spots; these are never numerous and on most of the spines are quite lacking but their occasional presence is contrary to the accepted distinctive character of the species—"collar not spotted or striped."

It is hard to understand why so conspicuous a sea-urchin has not been reported before from the vicinity of Fremantle. No little dredging and much shore collecting have been done in that vicinity in recent years, but this is the only specimen of Prionocidaris that has been reported as yet from south of Long Island in the Abrolhos, where a single example was found by Professor W. J. Dakin in 1913.

The 64 specimens of *bispinosa* in the present collection are from the following places:

Prionocidaris bispinosa, typical form:—

Western Australia: Broome, Pearl Shoal, 5–7 fms., August, 1929. 2 very small specimens.

Broome, dredged in 5–8 fms., September, 1929. 3 specimens.

Broome, dredged in 5–8 fms., June, 1932. 54 specimens.

Prionocidaris bispinosa var. *aruana:*—

Western Australia: Augustus Island, October, 1933. Captain Beresford E. Bardwell leg. 4 specimens.

Prionocidaris bispinosa var. *laevis:*—

Western Australia: Off Fremantle, Garden Island, April 25, 1914. Professor E. W. Bennett don. 1 specimen.

PHYLLACANTHUS IRREGULARIS

MORTENSEN, 1928. Vid. Med., **86**, p. 74.

There are four specimens at hand of this fine species and each deserves a word of notice. One is a very young individual, the smallest yet recorded; it measures only 15 mm. in horizontal diameter and 9 mm. in height; there are 6 coronal plates in each column and the primary spines are 10–15 mm. long by 1.5–2 mm. in diameter; they are nearly cylindrical, truncate at the fluted tip, with 8–10 longitudial series of pointed tubercles which pass into smooth ridges distally; miliary spines relatively few, small, narrow and pointed. Color yellowish brown orally but becoming dull purple aborally; oral primaries whitish but aboral ones dull purple with narrow encircling band near middle and the neck, lighter; collar dull-brown, like the secondaries of the midzone. Compared with a similar small specimen of *parvispinus* (19 mm. in diameter) the difference in the miliary spines is very striking and the relative slenderness of the primaries is also conspicuous. This important young specimen of *irregularis*, belonging to the Perth Museum, was kindly loaned to me by Mr. Glauert; it was found "under a stone on reef" at Bathurst Point, Rottnest Island.

A second specimen is a large adult taken at Point Peron, south of Fremantle, in July, 1930. It is 105 mm. in diameter and the primary spines are 60–65 mm. long; the color is a dark purplish brown but the primaries, beyond the collar, are light brown or almost white, in rather marked contrast.

The third specimen, generously given to the M. C. Z. by Professor G. E. Nichols of the University of Western Australia, is a magnificent individual about 110 mm. in diameter and 70 mm. high; there are 10 coronal plates in a column and some of the primary spines exceed 70 mm. The color is the usual dark purplish-brown but the primary spines are more or less dull purple, considerably darker than in the preceding specimen. The interporiferous area of the ambulacra has 3 or 4 series of miliary tubercles and the interambulacral areas are notably broad with the miliary spines very wide and flat, though acuminately pointed. This specimen was taken at North Beach, near Fremantle.

The fourth specimen is very different from the preceding two and looks like a different species. It was taken near Port Willunga, South Australia, by Mr. W. J. Kimber, some years ago, and is in rather poor condition, as many of the spines are missing, especially the smaller secondaries and miliaries. The test measures 82 x 50 mm. and the primary spines are 35–40 mm. long and 5–6 mm. in diameter. Most of the secondary spines are broken near the tips and many are missing altogether. Most of the miliary spines are also gone but those that are present are narrow and acuminate, not at all scale-like. The test where bare is light-brown with the secondaries, miliaries and collar of primaries a deeper brown with a purple tinge but not dark. Beyond the collar, most of the primaries are more or less encrusted with worm-tubes, bryozoa, etc., but where not so covered are dull purple or brown, generally rather light. Being puzzled by the appearance of this specimen I sent it over to Copenhagen for Dr. Mortensen to examine but did not give him any clue to the locality whence it came. He returned it to me with the suggestion that it was perhaps a variety of *parvispinus*. The miliary spines are, however, like those of *irregularis* and entirely unlike those of *parvispinus*, and the presence of 9 coronal plates in a specimen of this size is indication of *irregularis*. The very short primary spines offer, however, a striking difference between this specimen and the two large specimens of *irregularis* from the west coast which are at hand. I had, therefore, about decided to call this South Australian specimen a short-spined variety of *irregularis* when I noted that the type of *irregularis* in the Hamburg Museum also has very short spines, as do several others of those listed by Mortensen (1928, p. 520). Moreover, a specimen in the M. C. Z., received from the South Australian Museum, with no locality label, identified by Dr. Mortensen himself as *irregularis*, is very similar in color and spine length to the specimen under discussion; it is darker and the primary spines are not so stout but the two individuals are undoubtedly the same species. It is highly probable then that this specimen from an unknown locality was also taken in St. Vincent Gulf. A much larger series of specimens from both South and Western Australia must be available before it can be decided whether varietal forms in *irregularis* can and should be recognized.

PHYLLACANTHUS LONGISPINUS

MORTENSEN, 1918. K. Sven. Vet. Akad. Handl., **58**, no. 9, p. 4.

The occurrence of this species at Darwin and Port Essington as well as in the Broome region is worthy of special note, for it is the only regular echinoid at present known from both of those two areas, although there is little doubt that all of the echini common to Broome and to the Barrier Reef region are also to be found near Darwin.

The specimen from Port Essington is a bare test, 86 x 57 mm. with 7 coronal plates in each column (a youthful plate at the top of one column, with a rudimentary primary tubercle, might be counted as an eighth plate in one area). The largest specimen is from Cape Leveque and measures 90 mm. in diameter, 59 mm. high and the largest primary spine is 90 mm. long by 7 mm. thick. Another specimen from the same place is 73 mm. in diameter but has the primary spines 80–90 mm. long. In his original description, Dr. Mortensen says: "It would be interesting to know whether this species with its immense radioles is able to conceal itself under rocks and in crevices in the same way as *Ph. parvispinus*." The discovery of *longispinus* at Cape Leveque enables me to supply the desired information. The two specimens taken were found so tightly wedged in crevices in the coral rock, at extreme low water, that I almost despaired of getting them out in an undamaged condition before the incoming tide should drive me out of the tide pool where they were living. One was secured on August 21 and one on August 22. It was necessary to break away the surrounding corals and rocks with a hammer in order to get the animal free. The large spines were held perfectly rigid by the animal and it would be simply impossible to dislodge the creature without breaking the test, if the rocky surroundings were not broken up. It seems incredible that so clumsy looking an animal could get itself into such a restricted space. No doubt the spines are the locomotive organs by which the sea-urchin makes its way into such crevices and they then become organs of "attachment" and support which defy any ordinary enemies.

The smallest specimen at hand is from Augustus Island, about 150 miles northeast of Cape Leveque. It is only 52 mm. in diameter but the longer primary spines are 70 mm. or more in length.

Broken primary spines of a large Phyllacanthus, presumably this species, were occasionally dredged at Broome but we failed to secure a single specimen, although the types are from "Cape Jaubert" and "northwestern Australia." Considering the manner of life, it would be only under very unusual circumstances that a specimen would be taken in a dredge.

The 9 specimens before me are from the following localities:

Northern Territory: Coburg Peninsula, Port Essington, Smith Point, May 20, 1932. 1 bare test, washed up near high water mark. F. A. K. Bleeser leg. et don.
Darwin, November, 1931. 1 bare and broken test with spines. F. A. K. Bleeser don.
Darwin. Len Wilson leg. 2 fine specimens belonging to the Australian Museum.
Western Australia: Augustus Island, October, 1933. Captain Beresford E. Bardwell leg. 3 specimens.
Cape Leveque, August, 1929. 2 large specimens.

PHYLLACANTHUS PARVISPINUS[1]

TENISON-WOODS, 1879. Proc. Linn. Soc. N. S. W., **4**, p. 286.

A specimen from Shell Harbor, N. S. W., is the smallest individual of this species I have seen; it is 19 mm. in diameter, with 5 or 6 coronal plates in each column; the primaries are relatively large, 15–18 mm. long and 3 mm. or more in diameter. A young individual, 32 mm. in diameter, found under a rock between tide marks at Long Reef, N. S. W., is peculiar in having only one normal spine (or possibly two) above the ambitus; this one is 26 x 4.5 mm; adjoining it, in the same interambulacrum, is one 22 x 4; on all the other coronal plates, above the ambitus, the original spines have been either lost and are regenerating, or are broken at the tip. Apparently this individual had been much beaten about by the surf, for even below the ambitus some of the primaries are being renewed or are broken.

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[1] The specific name was originally printed in the feminine, *parvispina*.

Mortensen (1928, p. 516) quotes Benham (1911, p. 159) as authority for the occurrence of this species under the name *P. dubia*, at Lord Howe Island. I can find no tangible evidence to warrant the assertion that any Phyllacanthus occurs at that place but it is, of course, quite possible that this species might occur there. The record, however, probably rests on the occurrence of *Prionocidaris australis* which was originally regarded and long known as a Phyllacanthus.

The 5 specimens at hand are as follows:

New South Wales: Shell Harbor, under a rock above low water mark, May 4, 1932. 1 young specimen.
Port Jackson, Bottle and Glass Rocks, November 27, 1929. 3 specimens.
Colloroy, Long Reef, between tide marks, November 28, 1929. 1 young specimen.

CENTRECHINIDAE

CENTRECHINUS SETOSUS

Echinometra setosa LESKE, 1778. Add. ad Klein, p. 36.
Centrechinus setosus JACKSON, 1912. Phyl. Ech., p. 28.

It is interesting to note that not a single specimen of this abundant and widespread Indo-Pacific sea-urchin, or of any other species of the genus, was found by us in tropical Australia in 1929. We heard reports of large black sea-urchins, with long slender spines as occurring west of Cape Charles, near Port Darwin, but no specimens were ever seen. At Quail Island, somewhat further west, there is abundant coral growth and conditions seemed to us very suitable for Centrechinus but all search for them was vain. At Broome and especially at Cape Leveque, there are areas that seem admirably suited to these reef-loving urchins, but none were ever found.

In 1932, however, Lord Howe Island proved a home for this species, but it was not abundant. Young ones were taken on the reefs on the western side of the island but large adults were found only at Neds Beach where the living coral masses provide very satisfactory hiding places for them.

In 1933, Captain Bardwell found *setosus* at Augustus Island, northeast of Cape Leveque. He writes that they "were found on the outer side of Augustus and Champagay Islands. They were very plentiful in pure coral pools, in some cases so dense that the bottom of the pool and interstices in coral could not be seen. This group of islands is the only place I have seen them." The specimens sent to the M. C. Z. are small but typical. One would naturally conclude that the Champagay Islands are the western limit on the Australian coast for this genus, so characteristic of tropical reefs and shores in all parts of the world, but unfortunately for such a view, *setosus* and its closely related fellow-species, *savignyi*, have both been found on Houtman's Abrolhos.

The 5 specimens of *setosus* at hand come from the following points:
Lord Howe Island: April, 1932. 3 specimens, 1 adult and 2 young.
Western Australia: Augustus and Champagay Islands, October, 1933. Captain Beresford E. Bardwell. 2 small adults.

CENTROSTEPHANUS RODGERSII

Thrichodiadema rodgersii A. AGASSIZ, 1863a. Proc. Acad. Nat. Sci. Philadelphia, p. 354.
Centrostephanus rodgersii A. AGASSIZ, 1872. Rev. Ech., pt. 1, p. 98.

This sea-urchin has long been known from Lord Howe Island but we did not find it abundant there. The most interesting individual taken is only 13 mm. in diameter with the long, slender primary spines nearly 20 mm. in length—much like *tenuispinus* of Western Australia.

The spines are unicolor and not banded as they are in young Centrechinus. A specimen from Shell Harbor, N. S. W., is very similar to the little one from Lord Howe but is 20 mm. in diameter and some of the primaries are more than 25 mm. long. The largest specimen at hand is somewhat over 100 mm. in diameter but its longest primaries are less than 60 mm.

The 5 specimens at hand were taken as follows:
Lord Howe Island: April, 1932. 1 large adult and 1 very small individual.
New South Wales: Port Jackson, Bottle and Glass Rocks, November 27, 1929. 1 specimen.
Shell Harbor, May 4, 1932. 2 young specimens.

CENTROSTEPHANUS TENUISPINUS

H. L. CLARK, 1914. Records W. A. Mus., 1, p. 162.

This species seems to have a very restricted range on the western coast of

Australia. The types were taken between Fremantle and Geraldton; presumably they were dredged in moderately deep water, (19–120 fms.) as were most of the echinoderms taken by the "Endeavour" during her fisheries investigations on the western coast. Subsequently, Professor W. J. Dakin took specimens at Pelsart and Long Islands in the Abrolhos.

The four specimens now at hand were taken in February, 1930, by Messrs. Swan and Drummond near Green Island, at the extreme western end of Rottnest Island. They are small individuals, 38–57 mm. in diameter, with the slender primary spines 40–60 mm. long; the color shows some diversity; the smallest is quite brown with the spines fading to a very light brown at the tips, while the others are more nearly dull purple, with one quite definitely deep reddish-purple. The area where these urchins were found is described by Mr. Swan as "a raised level rocky platform, onto which spent waves occasionally broke. The temperature of the water was much higher than normal sea-water and close by were isolated colonies (a few feet across) of the true reef coral, Pocillopora." The specimens of Centrostephanus were found here in company with Echinometra which occurred in thousands in their customary cup-shaped depressions. Unlike Echinometra, however, Centrostephanus was "quite hidden under deep ledges and had to be felt for. They were, in life, colored a rich royal purple with the membranous parts a brilliant crimson." This account of the color in life is important as showing that no valid specific character is to be found therein to distinguish the western Centrostephanus from that of the east coast. The slenderness of the primary spines seems, however, to be a striking and constant difference. In view of the wide geographical separation of the two forms and the lack of intermediate specimens, either geographically or morphologically, they are best regarded as distinct species.

ECHINOTHURIIDAE

Asthenosoma intermedium[1] sp. nov.

Plate **26**, figs. 2–3

Test low and flat (very flat in the preserved specimens) with a nearly circular ambitus, about 120 mm. in diameter. Ambulacra with about 100 plates in each column of which rather more than 40 are on the oral surface; at ambitus, each ambulacrum is about 35 mm. wide; on the oral side, most of the ambulacral plates carry a primary tubercle near the inner end and, since the plates are very low, these tubercles are crowded into an irregular but fairly definite double series; primary tubercles in the poriferous areas are very rare indeed; on the aboral side, there are no large primary tubercles in the ambulacra, but as a rule each plate carries 3 or 4 secondaries; the poriferous areas are each about four-fifths as wide as the adjoining half of the interporiferous field, and carry scattered secondary tubercles in irregular and indefinite double columns.

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[1] *intermedius* = in the middle, in reference to its position between *A. varium* and *A. ijimai.*

Interambulacra with about 60 plates in each column, of which 27 or 28 are on the oral surface; at ambitus, each area is about 40 mm. wide; orally each plate carries 2–4 primary tubercles, distributed in irregular columns on each side of the area; the inner column is for the most part single while the adradial one is double but now and then the inner column is double and the adradial single; there are also scattered tubercles between these columns but they are usually somewhat smaller than the others and show no regular arrangement; dorsally, there are no primary tubercles but the more distal plates carry about 10 secondary tubercles in an irregular horizontal series; adapically the number of tubercles on a plate decreases to 3,2,1 or 0, so that a bare median area is indicated there, but it is very narrow and ill-defined, and is probably quite unnoticeable in the living animal; except for the uppermost 6–8, the plates are nearly straight, horizontally, only the innermost portion being bent downward; the membranous spaces between the plates are inconspicuous, except here and there in the adapical portion of the interambulacra.

Apical system about 25 mm. across, measured from the distal margin of an ocular to the tip of the opposite projecting genital; all the genitals appear to be divided into a number of irregular plates, of which an inner one is much the largest; madreporic pores not confined to genital 2, but occupying large portions of oculars II and III, and also occurring in one periproctal plate; ocular II divided into two parts, the outer one the larger, both being well-filled with madreporic pores; ocular III has the madreporic pores confined to the half adjoining genital 2. Peristome about 30 mm. across with 11 or 12 plates in each column; each plate carries a number of tubercles so the entire peristome is thickly covered with spines.

Oral primary spines commonly with conspicuous white hoofs, which are about 2 mm. long; they are not flaring but on the contrary are widest at the base and often taper slightly to the tip. The condition of the dried specimen makes it uncertain how well developed the poison glands on the secondary spines are, but there seems to be no doubt of their presence. Pedicellariae numerous but apparently all of one kind, tridentate with rather elongate heads, the valves (up to 2 mm. or more in length) in contact throughout, coarsely dentate near tips and more or less carinate on the back; they thus resemble the smaller tridentate form of *A. ijimai.*

Color of dry specimen: deep brown with a purplish tint; where the epidermis is rubbed off, the color is a lighter brown. Primary tubercles and surrounding scrobicular area, whitish. Spines light greenish, at least near tip, more or less banded with dull purplish-brown; often the bands are very faint or wanting, and usually they are noticeable only near the tips; the green tint and the bands are more evident on the large oral spines than on the very slender spines of the upper surface, but even orally the colors are dull. Probably they are much brighter in the living animal.

Holotype, M. C. Z., no. 7094 from the reef at Seaforth Island, near Lindeman Island, Great Barrier Reef, Queensland, Australia, July, 1934. Melbourne Ward leg. et don.

A smaller specimen of this interesting sea-urchin about 90 mm. in diameter, from the same locality, was also sent by Mr. Ward. Thinking the specimens were not identical with either *varium* or *ijimai,* I sent the smaller one to Dr. Mortensen for his opinion. He replied at once: "The Asthenosoma from the Barrier Reef I must regard as a new species. It is rather intermediate between *varium* and *ijimai* — in its pedicellariae nearer the latter." In only one particular does the smaller paratype differ markedly from the larger specimen — the madreporic pores are very clearly confined to genital 2. Evidently not much reliance can be placed on this character as a distinguishing mark between species, unless it has been attested by large series of specimens. The more numerous and very low plates, the tuberculation and the coloration distinguish the Australian species from *ijimai,* while the same features and the pedicellariae also, prevent confusion with *varium.* It is of no little interest that Mr. Ward has added this notable genus to the fauna of Australia.

TEMNOPLEURIDAE

TEMNOPLEURUS MICHAELSENI

Salmacis michaelseni DÖDERLEIN, 1914. Fauna Sudwest-Austral., **4**, p. 454.
Temnopleurus australis H. L. CLARK, 1928. Rec. S. Austral. Mus., **3**, p. 458.

The large series of specimens secured on the coast of Western Australia in 1929 leaves no room for doubt that this is one of the commonest sea-urchins of that region. It seems strange that it was not named until 1914, but there is nothing to indicate that specimens had reached the hands of zoologists before that year. In 1914, however, Döderlein studied a considerable series of specimens (he does not mention the number) and was so struck by their diversity that he at first thought he must distinguish "mehrere Arten" (1914, p. 457). With his usual good judgment, however, he finally concluded that they all belonged to a single species, which, in spite of the small size of the individuals, he placed in Salmacis because of the "wohlausgepragten Crenulierung" of the larger tubercles. This, however, is a character of Temnopleurus as well as of Salmacis, and Döderlein himself says, "Gerade dievorhiegende Art macht es auch schwer, Temnopleurus and Salmacis scharf zu trennen" (p. 458). The same year in an account of the echinoids in the Western Australian Museum (1914, p. 164) I discussed two bare tests of this species under the heading "Temnopleurus sp.," the condition of the specimens not justifying the giving of a specific name. In 1928, however, a detailed description of this Temnopleurus, based on a large series of specimens in the South Australian Museum, was published by me (1928, p. 458) under the name *australis*. Döderlein's *Salmacis michaelseni* was completely ignored, due to the careless assumption that so small a sea-urchin as this could not be a Salmacis; the failure to note that the figure given by Döderlein is enlarged three times misled me, but was wholly inexcusable. While I think that Temnopleurus is the proper genus for this urchin, the specific name proposed by Döderlein must replace *australis*.

This little echinoid is very abundant off Fremantle, especially near Garden Island. It is also occasionally washed up on the beach at Cottesloe in some numbers. While it may be found near low water mark, it is most abundant in depths of 3–8 fms. It rarely reaches 25 mm. in diameter but there is great diversity in the height of the test; a specimen 22 mm. in diameter from the vicinity of Garden Island is only 11 mm. high while one from Cottesloe Beach, of the same diameter, is 16 mm. high. The two forms completely intergrade. Specimens washed up on the beach look very different from those which are dredged, as the spines are so badly broken; few, if any, retain their tips and many of the small ones are lost altogether.

In color, considerable interesting diversity is shown but it is due to differences in intensity of shade rather than to any real difference in pigmentation or pattern. The test is primarily dull gray with a purplish tint, typically rather dark but sometimes quite light; the tubercles are cream-color and sometimes patches of that shade are present in the midzone in both ambulacra and interambulacra or in the latter alone; rarely the white area extends well up adapically or extends orally so the whole lower surface is light; the periproctal plates are often quite green and this color may extend to the tubercles and even to the poriferous zones on the upper half of the test, or sometimes clear to the peristome; in extreme cases the test as a whole is greenish. The miliary and secondary spines are pure white while the primaries are typically colored, but often some or many of the primaries, even orally, are white wholly or in large part; the colored primaries are commonly dark red or even red-brown at the base, passing into dull light red at middle, becoming green distally and often tipped with white; but the dark base may be nearly or quite wanting and in light-colored specimens the basal part of the spine may be as white as the tip; in some individuals the red shades are dull reddish-purple quite different from the deep brown-red which large specimens often show. Bare tests are dull purple or dull greenish or both, with or without cream-colored patches.

There are 3 specimens from an unknown locality on the coast of Western Australia, sent by Professor E. W. Bennett in 1930, which are so conspicuously different from all the other specimens that it seems best to distinguish them as a variety to which the name *viridis* may appropriately be given. Holotype, M. C. Z., no. 7103. They were evidently collected on some beach, possibly Cottesloe, for the spines are broken and mingled with fine sand as in other beach-drift specimens. There are practically no white spines except near the mouth where many primaries as well as secondaries have white tips. The test, including the tubercles, is dull gray with a greenish cast; only in the smallest specimen do the tubercles and poriferous areas appear lighter. The spines large and small are green with the tips usually lighter, often whitish, and the base of the larger ones brown or brownish, passing into green; there is little or no trace of red save on a few primary spines. The contrast between these specimens and the normal form is quite striking.

The 62 specimens of *michaelseni* at hand are from the following places:

Western Australia: Cottesloe Beach, 1929. 16 specimens, adult and young.
Fremantle, off Garden Island, 7 fms., October, 1929. 38 specimens, adult and young.
Fremantle, off Garden Island, 3–4 fms., July, 1932. 2 specimens.
Rottnest Island, Bathurst Point. 1 small adult.
Point Peron, October, 1929. 1 adult.
Bunbury, October 26, 1929. 1 young specimen.
Exact locality unknown. 3 specimens of variety *viridis*.

TEMNOPLEURUS TOREUMATICUS

Cidaris toreumatica LESKE, 1778. Add. ad Klein, p. 155.
Temnopleurus toreumaticus L. AGASSIZ, 1841. Mon. Ech.: Obs. Hist. Nat. Echinus, p. 7.

A very small sea-urchin in the Australian Museum material, from 9–12 fms., off Gatecomb Head, Port Curtis, Queensland, taken by Messrs. Ward and Boardman in July, 1929, is apparently a young individual of this species, for which Port Curtis seems to be the southern limit. It is 6 mm. in diameter and nearly 3 mm. high. The primary spines are white with the bases, and one or two rather faint, narrow bands, olive-greenish or greenish-brown.

From Townsville, Queensland, bearing the date May 17, 1929, there is an adult specimen, also belonging to the Australian Museum, 55 mm. in diameter and about 30 mm. high; above the ambitus, the spines are wanting. Those of the lower surface are 10 mm. or less in length but of the usual color, whitish more or less brownish olive at base, with faint bands of the same (or a lighter) shade.

SALMACIS BELLI

Salmacis sphaeroides var. *belli* DÖDERLEIN, 1903. Denkschr. Ges. Jena, **8**, p. 718.
Salmacis belli MORTENSEN, 1904. Dan. Exp. Siam: Ech., p. 68.

Mr. Melbourne Ward has sent me three beautiful young individuals of this notably handsome sea-urchin which he took in shallow water near Lindeman Island, Great Barrier Reef in September, 1934. The smallest is 8 mm. in diameter, the largest, 24 mm. The primary spines are notable for their length as well as for their rose-red and green colors. In the smallest specimen they are nearly equal to the test diameter; in the largest they are 12–14 mm. long.

SALMACIS SPHAEROIDES

Echinus sphaeroides LINNÉ, 1758. Syst. Nat. ed. X, p. 664.
Salmacis sphaeroides LOVÉN, 1887. Bih. Svensk. Vet.-Akad. Handl., **13** (4), p. 69.

In the vicinity of Broome, this well-known sea-urchin is occasionally met with but is not very common. All the specimens seen were brought up by a diver or were dredged in 7–8 fms. The coloration is a combination of white, green and red-purple but there is a great deal of diversity in the shades and relative amounts of these colors. In young specimens the test is greenish-white or pale apple-green but in larger specimens the shade may be lighter or considerably darker.

The spines are green at base but white distally with 3–8 narrow and distinct, but not sharply defined bands of red-purple. Many very small spines and the stalks of the pedicellariae are pure white. In large specimens the colors may be very light, greenish-white and brownish-red, but often they are darker and duller than in youth, dull brownish-olive and purple-brown being the component shades. Specimens from Queensland have retained the green color in their present dry condition much better than those from Broome.

The material at hand shows a range in size of from 8.5 x 5 and 13 x 7.5 to 80 x 51 and 82 x 46 mm. One old dead test, however, now badly broken, had a diameter of at least 90 mm.

The 18 specimens before me are from the following places.

Queensland: Great Barrier Reef, Lindeman Island, "dredged in shallow water on Caulerpa ground, September, 1934." M. Ward leg. 3 very fine adults.

Western Australia: Between Broome and Wallal, 8 fms., September, 1929. 2 very young specimens.

Between Broome and Wallal, 1930. R. A. Bourne leg. 1 small specimen. Loaned by Australian Museum.

Broome, 7–8 fms., June, 1932. 11 fine adults.

Southwest of Broome, 7–8 fms., June, 1932. 1 large dead test, badly broken.

SALMACIS VIRGULATA var. ALEXANDRI

Salmacis alexandri BELL, 1884. "Alert" Rep., p. 118.
Salmacis virgulata alexandri DÖDERLEIN, 1914. Fauna Sudwest-Austral., **4**, p. 454.
Salmacis virgulata var. *alexandri* H. L. CLARK, 1925. Cat. Recent Sea-Urchins, p. 88.

This is a common sea-urchin at Broome, occurring under rocks near low water mark as well as in deeper water. It was often dredged at depths of 3–8 fms. No specimens of typical *virgulata* were taken. Young individuals scarcely 5 mm. in diameter, or somewhat larger, were not rare, while the largest specimen taken is hardly 65 mm., not nearly so large as some from New South Wales. The diversity of color is striking and extraordinary; typical specimens have the larger spines dull reddish at base, passing into purple distally and tipped with white, but many individuals have a lesser amount of red or none at all; in some of these the red is replaced by a greenish-brown which becomes green distally, and in extreme cases (which might be called "forma" *viridis*) the test is greenish and the spines quite green with or without white tips; there is not a trace of either red or purple. In other individuals the red is crowded out by the purple and in extreme cases the test is purple and white, while the larger spines are entirely purple with white tips; there is not a trace of red or green. These extreme forms (to the purple one of which Mortensen (1918, p. 9) gave the name *Temnopleurus scalaris*) are so unlike it is hard to consider them identical but the connecting links are too numerous to leave any room for doubt. Mortensen has kindly examined a typical purple specimen and assures me it is his *scalaris*.

All of the 55 specimens of *virgulata* at hand were taken at or near Broome in August and September, 1929, and in June, 1932, excepting 4 sent to the Australian Museum by Mr. R. A. Bourne who took them between Broome and Wallal in 1930; they are half-grown or small adult individuals, 2 of the normal coloration and a typical example of each of the extreme color forms, *viridis* and *scalaris*.

TEMNOTREMA DECORUM

DÖDERLEIN, 1914. Fauna Sudwest-Austral., **4**, p. 459 (= *Pleurechinus bothryoides* AGASSIZ and DESOR, 1846 et auct. post., non *Pleurechinus bothryoides* AGASSIZ, 1841).

A very fine specimen of this beautiful little sea-urchin, 23 mm. in diameter and 18 mm. high, is at hand, loaned by the Australian Museum. It was taken in 1928, off Peak Point, northern Queensland, in 3–6 fms. of water, on rocky bottom.

A small bare test, 11 x 6 mm. was dredged at Darwin near South Shell Island, July 25, 1929. The bright green color was very noticeable at the time and is well retained by the dry specimen. In spite of the absence of the spines, so characteristic of *decorum*, the uniformly green color and the big, oval pits leave no doubt of the specific identity.

There are specimens of *decorum* from Holothuria Bank in the M. C. Z., received from the British Museum, but west of that region it is apparently replaced by the following species.

TEMNOTREMA ELEGANS

MORTENSEN, 1918. K. Sven. Vet.-Akad. Handl., **58**, no. 9, p. 12.

This handsome little sea-urchin is not rare in the vicinity of Broome and ranges southwestward as far as Rottnest Island. Döderlein (1914, p. 459) has recorded *T. decorum* from Shark Bay but he gives no information whatever as to the number, size or appearance of the specimens. It seems almost beyond question that they are really *elegans*. If there were but a single specimen and that a small one, it would be very natural to call it *decorum*. Mortensen is, however, fully justified in the establishment of a new species and in his choice of a name.

Several of the specimens at hand are larger than those available to Mortensen. The largest is 26 mm. in diameter and 19 mm. high, the height being thus more than 70% of the diameter. None of the other specimens is nearly so high relatively but they agree with Mortensen's in having the height about 60% of the diameter. The smallest specimen is 12 x 7 mm. The uniformity in coloration is notable, the least like the typical being shown by a small dry specimen from Rottnest Island, in which the ordinarily whitish spines are so suffused with reddish that the general cast of color is pinkish. In all the other dry specimens, the general cast is light brown, until examined carefully, when the violet-red color of the bands on the spines becomes evident. In one individual, 23 mm. in diameter, the larger bands on most of the primary spines are bright red, much as in *decorum*, but as the specimen is in all other respects exactly like the normal form, I think we may consider this aberration a bit of "reversion."

There are 8 specimens of *elegans* at hand, taken at the following places:

Western Australia: Broome, Pearl Shoal, 5–7 fms., September, 1929. 3 specimens, 2 adult and 1 young.
Broome, 5–8 fms., June, 1932. 4 specimens, 3 adult and 1 young (bare).
Rottnest Island, Bathurst Point. 1 half-grown specimen. Loaned by Western Australian Museum.

TEMNOTREMA SIAMENSE

Pleurechinus siamensis MORTENSEN, 1904. Dan. Exp. Siam: Ech., p. 79.
Temnotrema siamensis H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 318.

A Temnotrema with the test 11 x 6 mm., light greenish gray and whitish, and the larger spines, terete, white with the basal part, and usually a narrow band near tip, light brownish-red (or pinkish brown), has puzzled me. In spite of the terete spines, I thought it must be *siamense*, but I sent it to Dr. Mortensen for his judgment, and he endorsed the identification. It is a curious fact that this specimen, which belongs to the Australian Museum, was taken at the same time and place (in 1928, off Peak Point, northern Queensland, 3–6 fms., rocky bottom) as the fine specimen of *Temnotrema decorum* mentioned above.

Comparison of this specimen with the Temnotrema which I reported years ago from Mer (1921, Ech. Torres Strait, p. 150, pl. 17, fig. 5) has convinced me that that individual is a young *siamense* and not the Japanese species, *sculptum*, as I called it. The two species are very much alike but the pits in *siamense* are conspicuously larger than in *sculptum*. This distinction was stressed by Mortensen (1912, pp. 77–91) in his discussion of Pleurechinus (=Temnotrema) and in his key to the species (in which *sculptum* is included under the name *variegatus*). Correction of my error in identifying the Temnotrema from Mer as *sculptum* eliminates that Japanese species from the Australian fauna and suggests that it does not occur south of Formosa. On the other hand, *siamense* may be regarded as of normal and regular occurrence on the coast of northeastern Australia.

TEMNOTREMA NOTIUM[1] sp. nov.

Plate 26, fig. 5.

Test 9 mm. in diameter and 5 mm. high with small but very distinct deep pits in both ambulacra and interambulacra. Coronal plates 12 in each column; only 13 plates in each half-ambulacrum. Abactinal system about 3 mm. across, of which the periproct is one-half; genital plates pentagonal, as usual, with very large genital pores, and 2 or 3 relatively large tubercles on the inner margin; ocular plates small, markedly exsert, with a single secondary tubercle on the inner margin, proximal to which is a triangular pit, not very well defined; periproct with a large suranal plate at center and with no spines. Peristome 3 mm. across with 5 pairs of very small buccal plates, each with a pedicel; pairs well separated from each other but the two plates of a pair, closely side by side. Primary spines in midzone not quite 2 mm. long, terete or cylindrical, truncate but not at all capitate; the larger secondary spines are slightly swollen at tip. In the midzone, each coronal plate is noticeably wider than high and nearly rectangular; the pits though deep are so small they affect the form of the plates but little; each plate bears one large primary tubercle, above which is an irregular semicircle of very small tubercles, beginning at a small secondary tubercle on each side of the primary. Each ambulacral plate also carries one large tubercle, in addition to which there is a secondary and several miliary tubercles.

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[1] νότιος = *southern*, in reference to the type locality.

Pedicellariae rather numerous, but only ophicephalous were detected, and these are not distinctive.

Color of test gray-green, the poriferous areas distinctly lighter; larger tubercles white or light gray; in the midzone and on the basicoronal plates are a few irregular patches of white. Larger primary spines, flesh color at base, greenish near middle, white at tip; these areas are not sharply defined but seem to merge into each other; on the smaller spines, the greenish tint predominates, so that except for the basal part of the primaries, the general coloration is greenish and white.

Holotype, Australian Museum, No. J 3977, from King George's Sound, near Albany, Western Australia. E. le G. Troughton leg.

A second specimen, 7 mm. in diameter, may be regarded as a paratype, since it is essentially identical with the holotype and was taken at the same time and place. Both were originally identified as very young individuals of *Temnopleurus michaelseni*, and it was only after careful examination of considerable series of specimens that it became clear these specimens from Albany are really Temnotremas. Young *michaelseni* of this size have no real pits in the test, but small, shallow grooves, quite different in form and depth from those of Temnotrema. Moreover, the genital pores if present are small, the ambulacra are noticeably wider, and the color of the test is purplish, not green.

Satisfied that these little sea-urchins are Temnotremas, I have tried in vain to identify them with some previously known species of the genus. There is, however, no outstanding specific character and I can only say that *notium* is very close to *sculptum* and can be distinguished from that Japanese species only with difficulty. The one tangible and evident difference is that the suranal plate in *sculptum* (Plate 26, fig. 4) is of moderate size, in contact broadly with a genital plate and has a large plate adjoining it on each side, while in *notium* the suranal plate is relatively very large, near the center of the periproct and not in contact with a genital plate. I have no doubt that good series of adult specimens will demonstrate that *notium* and *sculptum* are quite distinct.

MESPILIA GLOBULUS var. PELLOCRICA

H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 322.

One of the most surprising of Captain Bardwell's discoveries, during his trip to Augustus and the Champagny Islands in October, 1933, was this interesting sea-urchin, not hitherto known from Australia, although the typical form has been reported from New Guinea. The specimens taken were found "under rocks" along shore and the color in life was "yellow-green." The nearest area where this variety is known to occur is in the Philippine Islands, some fifteen hundred miles to the north. Captain Bardwell sent five specimens, 21–37 mm. in diameter, exactly alike in coloration and, except that the green in the dried specimens is deeper and duller, they agree completely with the types of *pellocrica*. Thus another genus is added to the echinoid fauna of Australia.

Microcyphus annulatus

Mortensen, 1904. Dan. Exp. Siam: Ech., p. 101.

A single small specimen of this pretty species was given to me by Professor T. T. Flynn at Hobart. It is only a little over 6 mm. in diameter but the species is unmistakable. It was dredged by Professor Flynn, 6–9 miles off Schouten Island, Tasmania, in 40–50 fms.

Amblypneustes leucoglobus

Döderlein, 1914. Fauna Sudw. Austral., **4**, p. 463.

This sea-urchin seems to be rather common at Bunbury, W. A., where we dredged 8 specimens from 25 to 39 mm. in diameter. The height ranges from .80–.92 of the horizontal axis, but is generally much nearer .90 than .80. These specimens agree so well with Döderlein's description there is no doubt as to their identity. In normal condition, with the spines on, the form is readily identified but I do not think the bare tests can be distinguished from those of *ovum* with any certainty. Indeed, I am strongly inclined to question whether *leucoglobus* is really a valid species; it seems to me only a variety of *ovum* characteristic of the western coast of Australia. I am referring all my Amblypneustes from that area to *leucoglobus*, since they all have short, strongly capitate secondary spines, with the heads generally, or at least often, white. But those from Rottnest Island, if mingled with specimens of *ovum* from southeastern Australia, would hardly be picked out as distinct from the ordinary form.

Although I have examined hundreds of specimens of Amblypneustes, the species lines are still extemely hazy to me, owing to the lack of good series of all sizes, with the spines still on. A very large percentage of the specimens available in Museums are from "beach-wrack" and have the spines either broken and more or less crowded with grains of sand or wanting altogether. Until large series of specimens in normal condition can be examined, I do not think I can improve on the key to the species published in my British Museum Catalogue (1925).

The 16 specimens here referred to *leucoglobus* are as follows:

Western Australia: Dongarra. E. W. Bennett leg. et don. 1 bare test and 2 very young specimens, 4 and 9 mm. in diameter. In the smaller specimen the spines are distinctly banded; in the larger specimen this is scarcely evident, the primaries being dark green at base, lighter distally. The secondary spines show the markedly capitate and often white tips.

Rottnest Island, October, 1929. 2 adults with primary spines dark green basally, light distally as is so common in typical *ovum*.

Rottnest Island, 1933. B. E. Bardwell leg. et don. 1 adult and 2 half-grown specimens with primary spines dark green tipped with lighter.

Bunbury, Koombana Bay, 5–10 fms., October 26, 1929. 8 fine specimens; primary spines light green.

AMBLYPNEUSTES OVUM

Echinus ovum LAMARCK, 1816. Anim. s. Vert., **3**, p. 48.
Amblypneustes ovum AGASSIZ, 1841b. Mon. Ech.: Pref. Anat. Echinus, p. IX.

Only four specimens of this species are at hand and three of these are very young, 5.5–14 mm. in diameter, the two smallest being simply bare tests. Not one is typical and I am referring all to the variety *pachistus* (H. L. Clark, 1912, Mem. M. C. Z., **34**, p. 327). The only one worth mentioning was dredged at Hobart, Tasmania; it is 44 mm. in diameter and 36 mm. high. The height is thus a trifle more than 80% of the diameter. The test is very pale olive gray, the small spines range from nearly white to pale olive; the larger ones tipped with pale brown or dull reddish, and the primaries are dull reddish-purple, becoming brownish around the peristome. This individual looks very unlike a typical *ovum* and suggests again that *ovum*, as at present recognized, is really a composite of several species.

The 4 specimens at hand were taken as follows:

South Australia: St. Vincent Gulf, Port Willunga. W. J. Kimber leg. et don. 2 bare tests, very young.

St. Vincent Gulf, Port Willunga, November 2, 1929. 1 young individual.

Tasmania, Hobart, west side of the Derwent, 2–3 fms., November 15, 1929. 1 adult.

AMBLYPNEUSTES PALLIDUS

Echinus pallidus LAMARCK, 1816. Anim. s. Vert., **3**, p. 48.
Amblypneustes pallidus VALENCIENNES, 1846. Voy. Venus: Zoöph., pl. II, fig. 1.

This lovely little sea-urchin is abundant in Koombana Bay at Bunbury, W. A., where we took many specimens while dredging on a "weedy" bottom in 5–8 fms. The test seems to be always some shade of lavender or purple but the spines show great diversity; the primaries range from light green, usually more or less reddish at tip, to bright orange-red, greenish only at base; the secondary spines are commonly bright lavender but may be very pale, almost white, or at the other extreme may be quite brown with little indication of lavender. Some specimens are thus predominantly green and some orange-red, some quite light, others rather dark. In size these individuals range from a diameter of 10 to 36 mm. and in height from 8 to 30 mm.; the height ranges from 80 to 90% of the diameter.

Specimens similar to these from Bunbury were found on Cottesloe Beach and at North Beach above Fremantle, and a single bare test indicates that the species ranges as far north as Dongarra.

The 57 specimens, referred to *pallidus*, were taken at the following places:

Western Australia: Dongarra, 1 bare test, damaged.
North Beach, 1 specimen.
Cottesloe Beach, 2 specimens.
Bunbury, Koombana Bay, 5–8 fms. on "grassy" or "weedy" bottom, 46 specimens.
Albany, Middleton Beach. 1 bare test, young.
South Australia: Port Willunga. W. J. Kimber leg. et don. 6 bare tests, very young.

HOLOPNEUSTES INFLATUS

A. AGASSIZ, 1872. Bull. M. C. Z., **3**, p. 56.

All of the considerable series of specimens of this species show a notable uniformity in shape and color. They range in diameter from 13 to 63 mm. while the height ranges from 70% of the diameter to 100%; the smaller the specimen the less the height. This gradual change in proportions is surprisingly uniform for while there are now and then exceptions, it is generally true that small specimens are low and large specimens high; the full grown individuals have the height nearly or quite equal to the diameter. It is a curious optical delusion that such specimens appear to be distinctly higher than wide. The color of these specimens is a definite red-purple, varying in brightness but usually rather dull. In some small specimens the red-purple is not markedly conspicuous and the upper half of the test and many of the spines are grayish or even pale brown.

A very surprising thing about these sea-urchins is their habitat. It has long been known that most museum specimens are bare tests, picked up on beaches, and good specimens with a complete coat of spines are rare indeed. Moreover, living Holopneustes are seldom dredged and rarely found near low water mark along shore. At Point Peron, south of Fremantle, and at Bunbury, still further south on the coast of Western Australia, we discovered that the normal habitat of the living sea-urchin is in the distal portions of the fronds of large kelps (*Ecklonia radiata*). With its very numerous tube-feet, the urchin holds tightly around itself the smaller subdivisions of the frond and there it lives as in a cradle, raised far above the sea-bottom and continually provided with fresh supplies of food and oxygen, by the constant movement of the sea-weed in the ceaseless tidal and other currents. If, for any reason, the urchin releases the enclosing frond divisions, it, of course, falls to the bottom and sooner or later may be washed up on the shore, more or less bereft of its spines and often otherwise damaged. Heavy storms may uproot the Ecklonias in shallow or even moderately deep water and these, with the Holopneustes they carry, sooner or later become beach drift (or "wrack") and the sea-urchins quickly die there and rapidly lose their spines and their color. It would not be safe to assert that kelp-fronds are the only habitat of Holopneustes but we found living specimens nowhere else. At Bunbury small individuals, 13–18 mm. in diameter were common in small laminarias in shallow water near low water mark, but we found full-grown individuals only in uprooted and floating large kelp, evidently from deeper water. Apparently Amblypneustes does not occupy such a habitat, for we found no individuals of that genus in the laminaria fronds, but both species of Holopneustes, *inflatus* and *porosissimus*, were to be found there and nowhere else, except, of course, when washed up on the beach.

As a result of further observations made after my visit to Perth in 1929, Professor E. W. Bennett of the University of Western Australia, kindly wrote to me as follows, regarding the habits of Holopneustes:

"Evidence that alga-frequenting habit is normal in Holopneustes —

1. At Point Peron I found about 30 specimens in half an hour on Ecklonia, but have never found it in any other situation, apart of course from drift.
2. It is common at times as drift on sand beaches.
3. Specimens on algae are of all sizes.
4. Both at Bunbury and at Point Peron I found three specimens, and in one case four, on a single plant.

The urchin does not cling to the sides of the frond but by means of the tube-feet completely enswathes itself, whether living on the broad-leaved Ecklonia or on the finely pinnulate Cystophora; it is quite out of view and the way to collect it is to draw the weed through ones hands and investigate any lumps. The habit is perhaps the nearest marine equivalent to that of certain leaf rolling insects. The shortness of the spines and the spherical shape suggest themselves as adaptations or at least as advantages."

The 36 specimens of *inflatus* at hand were taken at the following places:

Western Australia: Fremantle, North Beach, August, 1920. E. W. Bennett don. 1 small adult.
Fremantle, Cottesloe Beach, beach drift, May 14, 1920. E. W. Bennett don. 4 specimens, small and poor.
Point Peron, October 11, 1929. 10 fine specimens, adult and young.
Rottnest Island, November, 1933. Beresford E. Bardwell leg. et don. 1 small specimen.
Rottnest Island, southwest coast, February, 1930. F. H. Drummond and D. C. Swan leg. et don. 1 adult specimen.
Bunbury, October 25, 1929. 15 specimens, young but fine.
Ellenbrook Beach, January, 1930. E. W. Bennett leg. et don. 1 small bare test.

South Australia: Port Willunga, November 2, 1929. 1 large adult, washed up on beach.
Port Willunga. W. J. Kimber leg. et don. 2 small adults, 1 bare.

HOLOPNEUSTES POROSISSIMUS

AGASSIZ and DESOR, 1846. Ann. Sci. Nat. (3) **6**, p. 364.

When typical specimens of this handsome species are compared with equally typical specimens of *inflatus*, the differences are so conspicuous, it seems impossible there could ever be any confusion between the two forms. But in the considerable series at hand, there are several individuals which are, to say the least, puzzling. The largest of these is 36 mm. in diameter, with the height about the same, as in *inflatus*. The color of the test is also the reddish-purple of that species, but the spines are dull light greenish and bright red, much as in *porosissimus*. A second specimen is similar in size and color but has the test much lower, only 31 mm. high, and the colors are brighter. A somewhat smaller specimen is similar but the colors are much duller. Finally, a specimen 26.5 mm. by 25, blends the colors of the two species to such an extent that one hesitates to call it by the name of either one. These specimens are all from the vicinity of Cape Leeuwin, a region where both *inflatus* and *porosissimus* occur plentifully, and it is easy to say that they are simply hybrids between the two. But, in the absence of any actual evidence that such hybridization occurs, it may be quite as correct to say they are simply "intermediates" which indicate that the specific differentiation between the two nominal species is not yet complete.

The specimens of *porosissimus* at hand range from 17 x 12 mm. to 54 x 45. One individual is 52 x 35 but very few specimens have the height less than 75% of the diameter and very few have it much in excess of 80%. The typical coloration of a gray-green test, with the small spines green and the primaries bright, almost vermilion red, greenish only at base, is very striking. In habitat and habits, *porosissimus* resembles *inflatus*.

The 42 specimens at hand are from the following localities:

Western Australia: Dongarra. E. W. Bennett leg. et don. 1 fine adult.
Fremantle, North Beach. 1 specimen.
Point Peron, October, 1929. 8 fine specimens, 7 adult and 1 young.
Ellen Brook Beach. E. W. Bennett leg. et don. 1 young specimen.
Cape Leeuwin, beach drift. E. W. Bennett leg. et don. 29 specimens.

Holopneustes pycnotylus

H. L. Clark, 1912. Mem. M. C. Z., **34**, p. 334.

A very fine Holopneustes taken at Shell Harbor, N. S. W., May 4, 1932, represents this species, though it is much the largest specimen I have seen. It is 58 mm. in diameter and 56 mm. high. The form of the test is thus much like that of *inflatus* but the tuberculation is conspicuously coarser and the color is very different. The test is light brown, and the spines, particularly the primaries, are a dull pale pink. Compared with specimens of *inflatus* of the same size, the differences are striking.

ECHINIDAE

Pseudechinus hesperus[1] sp. nov.

Plate **27**, fig. 1.

Test 7.5 mm. in horizontal diameter and 5 mm. in height, vertical diameter thus 66% of the horizontal. Coronal plates relatively stout, 10 in a column, each with a conspicuous primary tubercle and several secondaries and miliaries; interambulacra more than 2 mm. wide. Ambulacral plates 11 in a column, almost the same height as the coronal plates; a primary tubercle, almost as large as those of the interambulacra, is present on each plate, with one or more secondaries and miliaries; ambulacra about 2 mm. wide, somewhat narrower than interambulacra; poriferous zones very narrow, the pores small and the arcs vertical. Secondary and miliary tubercles relatively few but so distributed over the test as to leave no noticeable bare areas.

Abactinal system moderate about 2.5 mm. across, compact; genital plates relatively large with very large pores near the distal angle; madreporite swollen, with about 40 pores, and 3 small tubercles on inner margin; ocular plates small, all exsert but I is most nearly insert; periproct rather more than a millimeter in diameter, the conspicuous suranal plate covering fully half the area; tuberculation of the oculogenital ring sparse, each genital having 1 or 2 secondaries and 1 or more miliaries, while each ocular has 1 large, and 1 or more small miliaries.

Peristome 3.5 mm. across, without gill-slits, the membrane thin and naked save for the 5 pairs of rather large buccal plates, each of which carries a pedicel and several ophicephalous pedicellariae.

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[1] ἕσπερος = *western*, in reference to its occurrence in Western Australia.

Primary spines even at and below ambitus only about 2 mm. long, smooth, tapering to a blunt, somewhat truncated point. Secondary spines rather conspicuous from their noticeably expanded (but not capitate) tips. Globiferous pedicellariae not very numerous but quite distinctive; valves (fig. 35) about 165 μ long, the base 100 μ wide; blade quite short and rather wide, with a long and conspicuous end tooth and a somewhat smaller lateral tooth on the left side well below tip. Tridentate pedicellariae were not found. Ophicephalous pedicellariae numerous but not peculiar. Sphaeridia numerous and relatively conspicuous, ovoid and distinctly stalked; there is a vertical series of 4–6 in each ambulacrum orally.

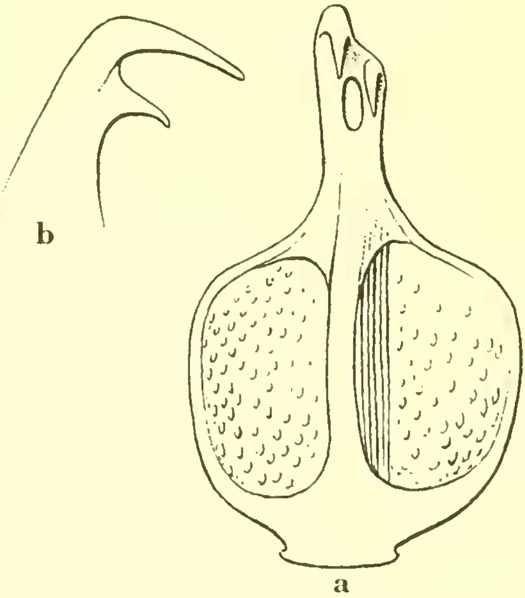

Fig. 35. Pseudechinus hesperus. Valve of globiferous pedicellaria. x 425. a. Inner view. b. Side view of tip.

Color of test very light lavender-brown, the abactinal system and poriferous areas light yellow-green in rather evident contrast; around peristome the test is nearly white. Spines very pale greenish or white, lightest distally; close to the peristome a few primaries are distinctly reddish at base.

Holotype, M. C. Z., no. 7151, from the cove, at the northeast end of Rottnest Island, off Fremantle, Western Australia, October 19, 1929.

The unique holotype of this interesting species was supposed, when taken, to be a young *Helioeidaris erythrogramma* and no particular attention was given to it until 1934, when it was sorted out from among a number of very small specimens of that species collected at Rottnest Island by me in 1929. It was at first considered an undescribed Nudechinus and I showed it to Dr. Mortensen while under that impression. He called my attention to the pedicellariae and suggested that it might be a new genus, but after critical study I see no reason why it is not a Pseudechinus. The globiferous pedicellariae are essentially like those of *Pseudechinus huttoni,* though the very short blade gives them a markedly different appearance. The noticeable sphaeridia of this individual may not be a constant feature of the species, and the failure of ocular I to reach the periproct is probably due to immaturity. The big genital pores, however, suggest that the species never reaches a very large size. The occurrence of Pseudechinus in Western Australia is particularly noteworthy, since the genus, common in New Zealand, was known hitherto in Australian waters only from the unique holotype of *Parechinus notius* H. L. C., taken in 70–80 fms. southeast of Cape Everard, Victoria. Dr. Mortensen considers this species very nearly related to *Pseudechinus huttoni* and "representing an Australian form of the genus Pseudechinus." The differences between *notius* and *hesperus* in test and pedicellariae are too obvious to permit any confusion between the two Australian species.

TRIPNEUSTES GRATILLA

Echinus gratilla LINNÉ, 1758. Sys. Nat. ed. X, p. 664.
Tripneustes gratilla LOVÉN, 1887. Bih. Svensk. Vet.-Akad. Handl., **13** (4), No. 5, p. 77.

In view of the wide distribution of this sea-urchin on the coasts and among the islands of the Indian Ocean, its complete absence from northern Australia is very striking. It is common on the Barrier Reef and along the Queensland coast, and has been reported from as far south as Port Jackson. On the coast of Western Australia, it has been taken once at Surf Point, near the southern end of Shark Bay, once at Pelsart Island in Houtman's Abrolhos and twice at Rottnest Island; the two specimens from Rottnest are in the University Museum at Perth; they are about 70 mm. in diameter and white in color; the smaller has the interambulacra dull purple. This occurrence, yet apparent rarity, on the northwestern and western coasts of the continent is, to say the least, puzzling. One may only speculate as to the possibility of accidental introduction by means of foul ship-bottoms. But from where?

All of the 14 specimens of Tripneustes at hand were taken at Lord Howe Island, where it is a rather common sea-urchin, but most of the individuals seen were young, ranging from 20 to 45 mm. in diameter. These occur under rock fragments on the reef flats and are commonly more or less concealed by the debris which they hold about them with their tube feet. As a rule, in these small specimens, the test is dark purplish or brown, the spines white, sometimes with a greenish tinge but without orange. Some specimens are quite reddish and in very small individuals the tube-feet may be a bright pale red. The largest specimen taken is 91 mm. in diameter. The handsomest was a large individual found by Miss Karna Birmingham on the eastern coast between Neds Beach and Middle Beach; the test was rich purple, the spines cream-white more or less tipped with bright orange and the tube-feet were banded brownish-red and white.

NUDECHINUS DARNLEYENSIS

Echinus darnleyensis TENISON-WOODS, 1878. Proc. Linn. Soc. N. S. W., **2**, p. 165.
Nudechinus darnleyensis H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 277.

There are three lots of small echini at hand which represent this species, described so long ago, but only understood since Mortensen's discussion (1904, p. 117) of its distinctive characteristics. There is a typical group of five specimens, 11–26 mm. in diameter, from northern Queensland. The smallest one has all the spines and tubercles white with no trace of violet but the upper portion of the test is largely dull gray in rather conspicuous contrast to the white periproct and adjoining parts of the ocular-genital ring. The next largest specimen has these grayish areas reduced in extent and depth of tint and most of the primary spines are bright violet with white tips. The third specimen has the test similar to that of the second but there is no violet; instead, the basal half of the primaries is pale brown, those of the peristomal region, showing an evident lavender tinge close to the milled ring. The fourth specimen has the supra-ambital primaries white but at the ambitus the very base of these spines becomes pinkish and this tint promptly passes, on the oral surface, into bright violet, only the very tips of the spines remaining whitish. The largest specimen is orally like the preceding but adapically only the smaller primaries near the periproct are wholly white, the remainder having the basal half violet of a lighter or darker shade. These five specimens are a very representative set in showing the development and diversity of coloration in the species.

A second group of four specimens are much alike in size and color and are obviously very young. They come from Moreton Bay (very far south for *darnleyensis*) and measure only 6–7 mm. in diameter. The irregular gray areas of the adapical region are fairly distinctive, though they are conspicuously violet to some extent in two of the specimens. In three individuals the primaries in the midzone are more or less violet, some conspicuously so, but in the fourth specimen, the violet is replaced by pale reddish brown. There is little doubt that these four specimens are very young examples of *darnleyensis*, thus extending the range of the species along the southern coast of Queensland well to the south of the end of the Barrier Reef.

A more surprising extension of the range of this distinctively Australian species is brought out by the third group, seven specimens dredged in 5–8 fms. of water in the vicinity of Broome, W. A. One of these specimens is a dead, bare test, but the others are unquestionable examples of *darnleyensis* and reveal the usual diversity of color. The smallest, only 9 mm. in diameter, has the test and spines adapically white but all of the primaries near the peristome are bright violet, a few even lack white tips. The next larger specimen is practically all white, only the primaries near the peristome showing a faint tinge of violet. In the next specimen the oral primaries are violet basally but above the ambitus, the primaries which are not white throughout are pale brown basally. A specimen 14 mm. in diameter is almost uniformly white with a yellowish tinge here and there, and a very few small primaries are faintly violet near base. The two remaining specimens are about of a size, slightly exceeding 20 mm. diameter, but one has most of the primaries, except near the apical system, bright violet, while the other has the violet primaries confined to the oral surface.

In the entire series of 16 specimens there are not more than four which can be considered adult, two from Queensland and two from Broome. Of the Queensland pair, the larger has ocular I only, insert and the other has all oculars exsert. In the pair from Broome, oculars I and V are both broadly insert; it may be added that in the smallest specimen (9 mm.), ocular I is fully insert, but in the 14 mm. specimen, all oculars are very completely exsert!

The three groups of specimens were taken as follows:

Queensland: northern coast, Peak Point, 3–6 fms., rocky bottom, 1928. 5 fine specimens, loaned by Australian Museum.
southern coast, Moreton Bay. 4 very young specimens, loaned by Victoria National Museum, Melbourne.
Western Australia: Broome, 5–8 fms., June, 1932. 7 specimens, adult and young, 1 a dead, bare test in poor condition.

NUDECHINUS GRAVIERI

Gymnechinus gravieri KOEHLER, 1905a. Bull. Mus. Hist. Nat., no. 3, p. 185.
Nudechinus gravieri H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 277.

It is only after long consideration that I have decided to refer to this Red Sea species, four small sea-urchins from Western Australia. Two of them are of the same size as the types of *gravieri* (12–13 mm. in diameter) and the form and coloration are apparently like Koehler's specimens. The abactinal system is surprisingly like Koehler's figure and description except that the ocular and genital plates have a few more tubercles. The test is greenish-white with conspicuous blotches of a rather deep green. The primary spines are nearly white with one, two or sometimes three rings of a dull pink or light brownish-rose. The larger secondary spines are white, many of them with the base conspicuously dark green, as in *N. scotiopremnus.* I have tried to convince myself that these specimens are young individuals of that species, but in addition to the dissimilarity in color, there are trivial differences in the abactinal system, in the tuberculation of the test and in the pedicellariae which are disconcerting, and I believe it is best to consider them identical with *gravieri* until more material of that species is available to make clear the relationship.

I sent the largest of my specimens to Dr. Mortensen for his opinion, suggesting that I thought it *gravieri.* His views deserve quotation:

"I do not feel sure that this identification is correct. Unfortunately, I have no specimen of *gravieri* but the description does not seem to me to fit very well with your specimen. The tubercles of the abactinal system are more numerous in your specimen. Koehler found no tridentate pedicellariae—in your specimen they are numerous, even round the mouth where Koehler found only ophicephalous pedicellariae, and Koehler does not mention the conspicuous dark bases of the spines. I think it about impossible to reach a final conclusion here without material from the type locality of *gravieri.*"

The tridentate pedicellariae to which Mortensen refers have the blades much wider and more rounded at the tip and less compressed at the base than do those of *scoliopremnus.* This is one of the reasons for not calling these little urchins the young of that species.

The four specimens at hand were taken as follows:

Western Australia: Broome, 5–7 fms., June, 1932. 3 specimens.
Bunbury, Koombana Bay, 5–8 fms., October 26, 1929. 1 very young specimen, less than 5 mm. in diameter, but apparently identical with the specimens from Broome.

NUDECHINUS SCOTIOPREMNUS

H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 277.

The discovery of this sea-urchin on the northwestern coast of Australia is very interesting, as it was previously known with certainty only from the Suez Canal, the Gulf of Suez and the Red Sea. A specimen in the M. C. Z. is labelled as from New Zealand but no confidence can be placed in this label. In the British Museum are three typical examples labelled "Swan River, J. B. Jukes," and I was rash enough to say (1925, p. 128) "it is unlikely that they came from West Australia!" Now I have to retract and say there is no good reason to doubt that they came from Western Australia.

At Broome, this sea-urchin was found on only one occasion; it was never dredged. Probably it occurs only under or among rocks where a dredge would rarely reach it. Early on September 24, 1929, a visit was made to a somewhat unpromising area near Broome, on the eastern side of Roebuck Bay, just south of the creek. In a rather large tide pool, under rock fragments, a number of white short-spined sea-urchins were found, together with a few bare tests. They were recognized as different from anything found previously, but our stay at Broome was nearing its end and as we were crowded for time, no careful examination of the specimens was made nor was a second visit to that particular collecting ground feasible. Great was my surprise, when the specimens were examined in Cambridge, to find that they were this Red Sea species.

At Perth, Mr. L. Glauert of the Museum called to my attention a number of fossil, or at least semi-fossil, echini and fragments of echini, which he had found at an island near the east end of Lake Herschel, on Rottnest Island. Professor E. W. Bennett also gave me specimens from the same locality. Some of Mr. Glauert's specimens are labelled "Quaternary deposits near Salt Lake, Rottnest Island, W. A." All of the Regular Echini found in these lots (except one fragment of Amblypneustes, probably *pallidus*) are *Nudechinus scotiopremnus* and critical comparison with Recent material fails to show any real differences. Diligent shore collecting has not yet revealed this species as living on the shores of Rottnest, but the Perth Museum has loaned me two specimens collected at the "Naval Base, Cockburn Sound, about half-way between Fremantle and Rockingham." Comparison of these specimens with those taken at the tide-pool in Broome shows that the primary spines are shorter, stouter and much more green but there is no doubt of their identity. The Recent specimens at hand range from 13 to 30 mm. in diameter; all are rather low, the vertical diameter seldom exceeding one-half the horizontal and one specimen 26 mm. in diameter is not 12 mm. high. Among the Quaternary specimens, however, two are notably high, the apical portion of the test being subconical; these specimens measure 26 by 16 and 27 by 17 mm.

In color, the specimens from Broome have the test ranging from greenish-white, lightest orally to rather dark green, light on the poriferous areas, and almost white at the peristome. The primary spines are white with the bases slightly or not at all green but the secondary spines, though white distally are otherwise more or less green, as a rule, and often a very dark green. In the two specimens from the Naval Base, Cockburn Sound, nearly all the primary spines are deep green basally, like the secondaries, and the specimens are thus much darker than any of those from Broome.

Aside from a dozen fossil examples, already mentioned, the 19 specimens at hand come from the following places:

Western Australia: Broome, east side of Roebuck Bay, tide pool, September 24, 1929. 14 specimens, adult and young, including 3 bare tests.
Shark Bay. 2 bare tests.
Dongarra, reef, 1928. E. W. Bennett leg. et don. 1 small bare test.
Cockburn Sound, Naval Base. 2 fine dark-colored specimens. Loan from Western Australian Museum.

STRONGYLOCENTROTIDAE

ECHINOSTREPHUS ACICULATUM

Echinostrephus aciculatus A. AGASSIZ, 1863. Bull. M. C. Z., **1**, p. 20.

The only specimen of Echinostrephus that we took during my two visits to Australia was found deep in a rock fragment at Neds Beach, Lord Howe Island, April 16, 1932. This specimen proved to be a short-spined example of the Hawaiian species, *aciculatum*, which was, of course, unexpected, the specimens of Echinostrephus thus far taken in Australian waters being *molare*. On returning to Sydney, I found an excellent series of this sea-urchin from Lord Howe Island in the Australian Museum and a dozen assorted specimens were generously loaned me for critical study. The 13 specimens at hand range from 16 to 29 mm. in diameter and show great diversity in color, in relative height and in the length of the abactinal spines; in other respects they are typical *aciculatum*. The color of the test is light brownish or more or less purple, becoming nearly white orally; the primary spines are commonly purple of some shade, sometimes brownish and dull, often deep and dark basally, becoming more red violet distally; in other specimens, however, the large spines are brown, greenish-brown or even yellowish-green; naturally the secondary and miliary spines are more or less in accord with the primaries; where the latter are purple or red-violet those shades are dominant in the smaller spines; where brown or green primaries are found, those shades characterize the small spines; in all cases, however, the spines adjoining the peristome are very light, either white or colorless, or faintly tinted with violet.

The relative height of these specimens ranges from about one-half the diameter to nearly or quite two-thirds; as a rule the smaller specimens are flatter than large ones but this is not invariably so; there is little doubt however, that after the specimen is 18–20 mm. in diameter, the vertical axis increases more rapidly than the horizontal. The diversity in the length of the abactinal spines is remarkable; a specimen 16 mm. in diameter has the abactinal primaries 16–17 mm. long, while a specimen 29 mm. in diameter has them only 12 mm. The longest primaries seen are nearly 28 mm. long on a specimen 28 mm. in diameter.

The occurrence of *aciculatum* at Lord Howe Island is very difficult to explain satisfactorily. On the Barrier Reef, *molare* has been taken at the Murray Islands and Low Isles. It is also known from the Solomon Islands and from Fiji, not to mention Mauritius and Zanzibar to the west and the Philippines and Japan to the north. On the other hand, *aciculatum* is known only from the Hawaiian, Gilbert and Society Islands. How and why this latter species should be the one to have reached Lord Howe Island is an interesting problem. Judging from the large number of specimens in the Australian Museum, it is common there, but our difficulty in finding specimens in April indicates that the season of the year or the state of the tides affects its accessibility.

PACHYCENTROTUS AUSTRALIAE

Sphaerechinus australiae A. AGASSIZ, 1872. Bull. M. C. Z., **3**, p. 55.
Pachycentrotus australiae H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 349.

A fine large specimen, lacking most of its spines, taken evidently in beach wrack, at Port Willunga, S. A., by Mr. W. J. Kimber, has been very generously sent to me by the collector. In this specimen, the test is whitish or faintly gray-lavender, becoming distinctly greenish on the abactinal system. Oculars I and V are broadly insert. The spines are light violet but the bases of the abactinal primaries are dull greenish gray.

There are 3 very young individuals at hand, belonging to the Australian Museum, collected by W. Irwin Smith, January 27, 1928, at Eagle Hawk Neck, Tasmania. These range from 10 x 5 to 16 x 9 mm. and are distinctly green in color without a trace of violet, apparently an indication of immaturity, but not impossibly a local color form. The tests are white orally but become more or less green adapically and even dusky on the abactinal system. The small spines are white. The primaries are green, dark at base, nearly or quite white at tip; just below the white tip is often a dusky band. Oculars I and V are insert in all three specimens. In the smallest specimen, the buccal membrane is rather sparsely plated, more so in the largest and most completely in the third.

HELIOCIDARIS ERYTHROGRAMMA

Echinus erythrogrammus VALENCIENNES, 1846. Voy. Venus: Zoophytes, pl. VII, fig. 1.
Heliocidaris erythrogramma AGASSIZ and DESOR, 1846. Ann. Sci. Nat. (3), **6**, p. 371.

This appears to be the commonest sea-urchin along the coast of southwestern Australia from Fremantle to Albany; the entire range is from Shark Bay to Port Jackson. The large series of specimens at hand suggests, what shore-collecting demonstrated completely, that the supposed species *armigera* A. Ag. and *hartmeyeri* Död. and the variety *meridionalis* Död. have no validity, though the name *armigera* may be retained for convenience in designating a variety or form with very short, stout primary spines which occurs under certain conditions of sea and shore. Just what the conditions are which favor its appearance is yet to be determined. At the opposite extreme is a much rarer form which we may call variety *parvispina*, in which the primary spines are nearly or quite wanting; if any are present they are very small. The secondary spines on the other hand are extremely numerous. The specimen which is selected as holotype of this variety (M. C. Z., No. 7185) is 80 mm. in diameter and 40 mm. high. Such primary spines as are present are 8–11 mm. long and more than 1 mm. in diameter, but one broken primary on the dorsal side is 2 mm. in diameter and was probably 15 mm. or more in length. The color of this individual is a uniform red-purple. A second specimen is about 52 mm. in diameter, has 4 rather stout primaries on the dorsal side, and is brownish-green in color.

Professor E. W. Bennett has kindly sent me the following notes regarding the occurrence of the form *armigera* and the typical form with longer, more slender spines. As a rule *armigera* tends to be purple or brownish-red in color, while typical *erythrogramma* is light green but there is no constant difference whatever in this particular. Professor Bennett writes:

"The precise habits of *H. erythrogramma* s. str. and of the *armigera* form require investigation.

"This urchin is most abundant at Point Peron, where the limestone in which it burrows is very soft. At Middleton Beach, where the rocks are granite, I found it only under stones below lowest water mark, and among the hard basalts at Bunbury it is equally rare.

"At Point Peron the outer reef, which I investigated on that second morning, is largely built up by calcareous algae, especially round the edges, where there is a rim several inches above the level of the rest. The rock is rotten for a depth of about a foot, and an incoming wave gushes up through the holes, after travelling through the sub-surface caverns; the crest of the wave, breaking over the surface, arrives distinctly later. This is the most prolific locality of all for Heliocidaris.

"Heliocidaris is not common at Bunker's Bay, occurring only under large rocks on seaward side of reef. Similarly at Albany; found only under large rocks at or below extreme low water mark, and not common. None found alive at Ellen Brook Beach. I think we found none at Bunbury, in the basalt reef. The rocks in all of the above localities are hard. The urchins are very common, however, in soft limestone, where they shelter in holes, e.g., at higher level, right in the swirl of the waves. Those from Ellen Brook Beach were all of the *armigera* type, only one with green color, and this had short stout spines. I have seen a fair number of Heliocidaris from Bunbury, collected by the Naturalists Club and by Mr. Whitlock. They are all 'drift,' perhaps from below tide-marks and are invariably *H. armigera*. Mr. Whitlock was quite unfamiliar with green or slender-spined specimens."

The 75 specimens of *erythrogramma* at hand range in size from 5 mm. to 86 mm. in diameter. Their diversity in color and in spinulation need not be discussed further here. They were taken at the following places and may be grouped as follows:

Variety *armigera:* 11 specimens.

Western Australia: Rottnest Island, 1933. Beresford E. Bardwell leg. et don. 1 specimen.

Point Peron, October, 1929. 7 specimens.

Bunbury, October, 1929. 2 small specimens.

South Australia: Port Willunga. W. J. Kimber leg. et don. 1 small specimen.

H. erythrogramma: 62 specimens.

Western Australia: Fremantle, October, 1929. 1 young specimen.

Rottnest Island, Bathurst Point, December, 1929. Perth Museum coll. 6 specimens, young and very young.

Rottnest Island, October, 1929. 3 young specimens.

Rottnest Island, southwest end, February, 1930. Drummond and Swan leg. et don. 4 small specimens.

Rottnest Island, 1931. G. Bourne leg. 1 very young specimen.

Rottnest Island, 1933. Beresford E. Bardwell leg. et don. 16 specimens, adult and young.

Point Peron, October, 1929. 13 specimens, adult and young.

Bunbury, October, 1929. 9 specimens, young and very young.

Ellen Brook Beach, January, 1930. E. W. Bennett leg. et don. 1 deformed adult and 1 young specimen.

Cape Leeuwin, January, 1930. E. W. Bennett leg. et don. 1 small specimen.

Albany, King Georges Sound. E. le G. Troughton leg. Australian Mus. coll. 1 young specimen.

South Australia: Port Willunga, October, 1929. 2 specimens, 1 adult, 1 very young.

Port Willunga. W. J. Kimber leg. et don. 1 specimen.

Tasmania: eastern coast, off Schouten Island, 40–50 fms. T. T. Flynn leg. et don. 1 very young specimen.

New South Wales: Port Jackson, Bottle and Glass Rocks, November 27, 1929. 1 young specimen.

Variety *parvispina:* 2 specimens.

Western Australia: Point Peron, October, 1929. 2 specimens, adult.

HELIOCIDARIS TUBERCULATA

Echinus tuberculatus LAMARCK, 1816. Anim. s. Vert., **3**, p. 50.

Heliocidaris tuberculata H. L. CLARK, 1912. Mem. M. C. Z., **34**, p. 282.

We did not meet with this species anywhere on the coast of continental Australia but it is very common at Lord Howe Island where it is a conspicuous feature of the reefs and especially of the reef flat near Mt. Lidgbird. The color is a bright brown, with a red tinge to test and pedicels, and greenish tips to the spines, very marked. The 20 specimens at hand range from 10 to 106 mm. in diameter. There is considerable diversity in the length of the primaries for while typical adults have these spines 50–60 mm. long, several specimens, including the largest, have them only 30–35 mm. The form and stoutness of the spines also show great diversity; the typical form is relatively slender and terete, tapering to a blunt point (for example, 55 mm. long, 3 mm. in diameter at base, 1 mm. in diameter 5 mm. from tip); often, however, the form is stouter and more cylindrical, tapering only near or at the tip (for example, 25 mm. long, 2 mm. in diameter at base and almost 2 mm. in diameter 5 mm. from tip); on the oral surface and not rarely at or even above the ambitus the primaries are distinctly flattened at the tip and not pointed. Probably all of these peculiarities in the spines are correlated with the degree of exposure to the surf, under which the animals live.

ECHINOMETRIDAE

PARASALENIA GRATIOSA

A. AGASSIZ, 1863. Bull. M. C. Z., **1**, p. 22.

The discovery of this interesting genus on the mainland coast of Australia, west of Torres Strait, is most interesting. The first and only specimen secured by us is a bare test, 35 mm. long, 29 mm. wide and 16 mm. high; the abactinal system is missing and the test is bleached white, only the large tubercles and the extreme adapical portion of the interambulacra showing a distinctly grayish tinge. My friend, Mr. F. A. K. Bleeser, found this test, washed up above high water mark on the sandy beach of Allaru Island, Coburg Peninsula, May 22, 1932. It is the second largest individual recorded; one, in the British Museum, from an unknown locality, is a millimeter longer and 3 mm. wider.

In the fine material received from Captain Beresford E. Bardwell, taken by him at Augustus and the Champagay Islands, in October, 1933, are ten specimens of Parasalenia, which he says "were found under rocks; body was a deep purple and spines which are blunt were deep purplish-gray (more gray). Fairly plentiful." These seem to be undoubtedly *gratiosa* but the habitat is very different from that occupied by this species at the Murray Islands, where all of the few specimens taken by me in 1913 were found among corals. Captain Bardwell's specimens range in size from 20 x 18 x 9 mm. to 32 x 28 x 15.5. There is notable diversity in the form of the test as the ambitus ranges from nearly circular (26 x 25 mm.) to long elliptical (31 x 23) and the height of the test from .40 to .48 of the long axis. The longest primary spines nearly equal the short diameter of the test in most of the specimens. There is little diversity on the whole in the abactinal system. In no case is a genital plate shut out from the periproct but in two specimens split genitals occur. The genital plates nearly always bear at least one and often two (or even more) secondary tubercles and spines. In eight specimens there are the usual 4 anal plates but in one case, one of the plates is divided into two unequal parts. In one specimen there are 6 distinct but somewhat unequal anal plates and in one, there are 5 rather large and 9 granule-like plates, the latter forming a group at the center of the periproct.

The specimens are now dry and show some diversity of color; in all, the test is very dark, blackish or deep purple; in eight the primary spines are grayish-brown but in two the brown is so nearly wanting that the spines are quite gray, dark in one case, light in the other. In these two cases, the white milled ring at the base of the spines is conspicuous but it is less so in the other specimens and in some cases is not at all noticeable. In life it is a rather striking feature of the species. In none of the specimens is there the least hint of the red or of the banded primaries characteristic of *P. poehlii*. All seem to be typical *gratiosa*.

ECHINOMETRA MATHAEI

Echinus mathaei DE BLAINVILLE, 1825. Dict. Sci. Nat., **37**, p. 94.
Echinometra mathaei DE BLAINVILLE, 1830. Dict. Sci. Nat., **60**, p. 206.

The distribution of this common Indo-Pacific sea-urchin on the Australian coast is peculiar and hard to understand. Except foı a single specimen from the Gulf of Carpentaria (McNeill and Livingstone, 1926), there is no record of an Echinometra from the northern coast of Australia between the Barrier Reef and Shark Bay! The specimens from the latter locality are recorded by Döderlein (1914, p. 487) under the name "*Mortensenia oblonga*." This is not the place to discuss the validity of the genus Mortensenia or the species *oblonga*, but Döderlein's account justifies the opinion that the specimens he had in hand would be called by me *Echinometra mathaei*. This view is confirmed by the very interesting discovery made by Messrs. Swan and Drummond in February 1930 that *mathaei* is a common sea-urchin at the southwest corner of Rottnest Island, off Fremantle. Mr. Swan writes of this discovery: "We finally camped at Nancy Cove on the south coast separated by some four miles of rough track from the Hostel and by a similar distance of very much rougher travelling from the extreme west end (Cape Vlaming)." "Echinometra was present in thousands, almost touching and quite exposed, being covered by only a few inches of water, on a raised level rocky platform onto which spent waves occasionally broke. The temperature of the water was much higher than normal sea-water and close by were isolated colonies (a few feet across) of the true reef coral (Pocillopora). The upper surface of the rock was pock-marked with cup-shaped depressions a few inches across and the urchins were like eggs in a nest in each depression." "Heliocidaris was not seen on the western end of the island." In speaking further of Echinometra, Mr. Swan adds: "It was interesting to note the wide range of color exhibited by different specimens. Some were distinctly greenish and ranged through reddish forms to a distinct, though dull, purple. Also a great variation in the regularity of the tests was seen, permitting them to fit firmly into small depressions in the rock from which they were with great difficulty removed owing to their attachment by the short flattened spines of the oral surface."

The absence of Echinometra from the rocky shores of Cape Leveque was a surprise to me, and Captain Bardwell's failure to find it further east at Augustus, and the Champagay Islands, is even more inexplicable. Whence came the Echinometras of Shark Bay and Rottnest Island? The latter locality by the way is the most southern at which these echini have been taken, so far as the published records show.

On the eastern coast of Australia, *Echinometra mathaei* has long been known from Lord Howe Island, which is almost as far south as Rottnest. Attention should be called to the notable photograph taken by Mr. A. Musgrave of Echinometras at Lord Howe, published by McNeill and Livingstone (1926, pl. XVII). We found it very abundant there in all suitable localities but it is particularly noticeable on the reef-flat near Mt. Lidgbird. My field notes say: "4 color forms noted; test always blackish; spines green (more or less olive); or dull pinkish; or gray; or gray abruptly tipped with white, very handsome." In size the specimens ranged from very small (8 mm. long) up to adults 65 mm. long by 56 mm. wide and 34 mm. high. Comparison of these specimens with those from Rottnest Island shows the most surprising similarity in form and tuberculation and in the spines. Even in color the difference is not remarkable, the only point worth noting being the absence from the Rottnest series of individuals with white-tipped primaries. Of course, this does not necessarily indicate that such individuals are not to be found at Rottnest.

The 20 Echinometras at hand were taken as follows:

Lord Howe Island: April, 1932. 12 specimens, adult and young.
Western Australia: Rottnest Island, near Cape Vlaming, February, 1930. Swan and Drummond leg. 8 specimens, adult and young.

CLYPEASTRIDAE

Clypeaster australasiae

Echinanthus australasiae Gray, 1851. Proc. Zool. Soc. London, p. 34.
Clypeaster australasiae H. L. Clark, 1914. Mem. M. C. Z., **46**, p. 32.

A single specimen of this well-known clypeastroid was picked up on the beach of the lagoon at Lord Howe Island near the Lidgbird reef-flat. It measures 125 x 100 x 34 mm. It had evidently been dead for some time but many nearly white or almost colorless spines are still attached to the upper surface of the gray test, particularly near the posterior end. The peculiar coloration is undoubtedly due to bleaching in the sun.

Clypeaster telurus

H. L. Clark, 1914. Rec. West. Austr. Mus., **1**, p. 166.

This fine species appears to be fairly common at Broome, as we took several specimens while dredging in and near Lagrange Bay in 1929 and more were secured in the same vicinity and near Roebuck Bay in 1932. Of these eight specimens, the smallest is 77 x 71 x 9 mm. and the largest is twice as large, 157 x 145 x 18 mm. The similarity in proportions is striking but none of the other specimens is essentially different. The smallest specimen is a purplish brown, noticeably different from the yellowish brown of the other specimens; its youthful character is also emphasized by the rather definite outlining of the coronal plates, due to the absence of spines on and close to the sutures. In life, the adult specimens are a bright dark brown. One specimen is deformed by the lack of a considerable part of the posterior end of the test on the left side; ambulacrum I from peristome to margin is 64 mm. long while V is only 53 mm.

The injury evidently occurred long ago for the margin is completely healed and normal in appearance.

The type locality for this species is between Fremantle and Geraldton so it was not a surprise to dredge a very fine specimen, 122 x 110 mm. in size, in 10–12 fms. between Rottnest Island and Fremantle.

HESPERASTER[1] gen. nov.

Test distinctly longer than wide, moderately arched, much as in Clypeaster; petals large, with diverging, or distally parallel, poriferous areas; oculogenital madreporic body very small; genital pore in interambulacrum 5 wanting; periproct rather large, on the flat oral surface, one-third of the way between margin and peristome; peristome larger than periproct, its membrane covered with numerous small plates; lantern very large and very flat as in Arachnoides; auricles large and well separated; interior of test very largely filled with countless calcareous pillars of varied size as in Clypeaster; tridentate pedicellariae like those of Clypeaster.

Genotype, *Hesperaster arachnoides* sp. nov.

This remarkably interesting genus is so completely intermediate between Clypeaster and Arachnoides that it prevents the segregation of the latter genus in a family or even a subfamily of its own, and thus necessitates including it in the family Clypeastridae. Hesperaster has the form and general appearance of Clypeaster; the position and character of the periproct, the internal structure of the test, and the pedicellariae are also as in that genus. On the other hand, the small oculogenital madreporic mass with only 4 genital pores, the very widely open petals, the plated peristome and the excessively flattened lantern are characteristic of Arachnoides. The genus appears to contain two species both from the coast of Western Australia, but the exact status and relationship of the two forms cannot be satisfactorily determined until more and better material is available.

HESPERASTER ARACHNOIDES[2] sp. nov.

Plate 27, fig. 2

Test a somewhat elongated pentagon with each of the five parts including an interambulacrum and half an ambulacrum on each side thereof, more or less convex marginally and sharply defined on each side by a conspicuous though shallow mid-ambulacral groove; where this groove reaches the margin there is a more or less evident shallow notch. Test 130 mm. long, 121 mm. wide just back of apical system, and 17.5 mm. high a little in front of that system. Upper surface rather uniformly arched from the thin, almost flattened margin; oral surface almost perfectly flat the peristome being but little depressed. Apical system 65 mm. from anterior margin; center of peristome 60 mm. from the same point.

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[1] *ἕσπερος = western + ἀστήρ = a star;* in reference to Western Australia and in conformity with Clypeaster.

[2] *arachnoides*, in recognition of its resemblance to the genus with that name.

Petaloid area about 75 mm. long and equally wide, for the five petals are surprisingly similar to each other in size and form, though the posterior pair are a trifle curved distally; each petal is 35 mm. long and 23 mm. wide at tip, the interporiferous area occupying 15 mm.; poriferous areas become very narrow and indistinct proximally; ridges between pore-pairs crowded with a series of 15–20 minute tubercles; oculogenital madreporic mass scarcely 3 mm. across; genital pores 4, none being present in the posterior interambulacrum.

Periproct pyriform, 8 mm. long by 5.5 wide at the rounded distal end, covered by minute spine-bearing plates; posterior margin of periproct, 18 mm. from test margin. Ambulacral grooves of oral surface deep, straight and conspicuous. Peristome circular, 9 mm. in diameter; peristomal membrane covered with numerous crowded small plates which bear no tubercles of any sort. Lantern very large (58 mm. across) and very flat (9 mm. high); three of the jaws have irregular osseous concretions, apparently pathological; in form and appearance the lantern is very much like that of Arachnoides; auricles 2.5 mm. high, expanded to nearly 2.5 mm. across at tip, the two of a pair are 6 mm. apart but only 3 mm. separates them from the adjoining pairs. Interior of test outside lantern, practically filled with calcareous pillars of diverse sizes, as in Clypeaster.

Test densely covered with spines; dorsally these are minute miliaries, less than a millimeter long, thickened at tip; orally there are numerous slender, more or less pointed spines, 1.5–3 mm. long, as well as many miliaries; the longest spines are around the peristome and reach a length of 4 mm. Pedicellariae very few; only two were found; these were tridentates with jaws about half a millimeter long, in form closely resembling those of *Clypeaster virescens* Död. (See H. L. Clark, 1914, pl. 123, fig. 29.)

Color in life "grayish light brown — quite evidently grayish;" the dry specimen has the test distinctly gray but the spines, especially the larger ones, tend to be yellow-brown.

Holotype, M. C. Z. no. 7196, dredged in 10–12 fms. between Rottnest Island and Fremantle, W. A., October 19, 1929.

Besides the superb holotype, we took in another haul of the dredge at practically the same place a young individual, measuring 31 mm. long, 30 mm. wide and 3.5 mm. high. There are no genital pores and the poriferous zones tend to converge distally; otherwise the specimen is surprisingly like the adult, save in color; the upper surface has a distinctly purple tinge, while the oral surface is light yellow blotched with a darker shade. The periproct is as far from the margin, relatively, as in the adult.

Fragments of a bleached test of what is evidently this same clypeastroid were given to me by Professor E. W. Bennett. They were found at Cape Leeuwin, W. A., in January, 1930, by Mr. D. L. Serventy. The test must have been some 100 mm. in length when the animal was living, as the fragments have a radial measurement of about 50 mm.

HESPERASTER CRASSUS[1] sp. nov.

Test elliptical in outline but with slight notches at the margin in each ambulacrum, at the tips of the ambulacral grooves, which are faint or wanting within the petals but are distally evident, especially in the posterior ambulacra. Test notably stout, the coronal plates being .75–1.00 mm. thick and the test margin nearly or quite 3 mm. Length about 35 mm. (posterior margin defective), width rather more than 30, height 8. Upper surface uniformly arched, highest at the apical system, which is 17 mm. from the anterior margin, and thus central in position. Oral surface seriously defective but it was nearly flat or a trifle concave and the peristome was at its center and scarcely depressed. Periproct missing.

Petaloid area about 18 mm. long by 17 mm. wide; petals not quite alike; petals I and V are 8 mm. long by 5 mm. wide, with the interporiferous area at tip, 3 mm. across; petals II and IV are a trifle longer and slightly wider; petal III is 9 mm. long but only 4.5 wide with the interporiferous area scarcely 3 mm. even at tip; ridges between pore-pairs with only 4 or 5 tubercles; oculogenital madreporic mass, 2 mm. in diameter with 4 large genital pores.

Lower surface so defective nothing can be said of the periproct but half the peristome is present, showing that it was circular, 3 mm. in diameter and central in position. As the specimen is subfossil, nothing can be said as to spines, pedicellariae or color. Enough can be made out of the interior to indicate separate auricles and numerous vertical pillars.

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[1] *crassus* = heavy, solid, in reference to the relatively thick margin and the stout appearance.

Holotype, Western Australian Museum, no. 115–37, taken from a "quarternary deposit near salt lake on Rottnest Island, W. A." Loaned by Mr. L. Glauert of the Western Australian Museum.

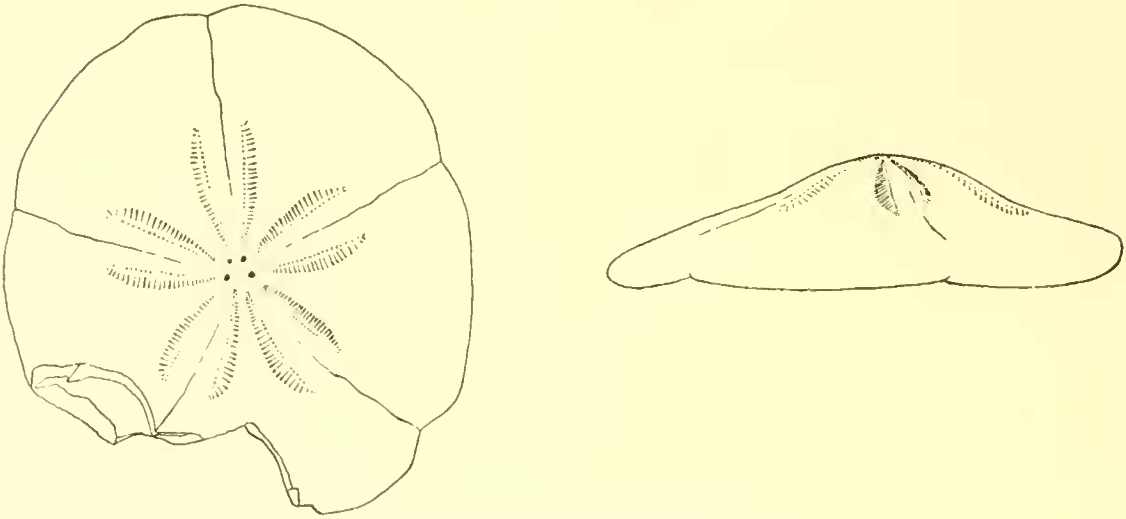

Fig. 35A. Hesperaster crassus sp. nov. x 2.

Comparison of this specimen with the young individual of the preceding species shows at once that they are very distinct and yet are congeneric. The differences in form and stoutness of the test, in genital pores, and in the shape of the petals are conclusive. The fact that the holotype of *crassus* is subfossil does not indicate that the species is extinct. All of the other echinoids found in this deposit are recent species now living on the Western Australian coast and it is quite possible that further dredging will bring to light living specimens of *Hesperaster crassus*.

ARACHNOIDES PLACENTA

Echinus placenta Linné, 1758. Sys. Nat. ed. X, p. 666.
Arachnoides placenta Agassiz, 1841. Mon. Ech., Mon. Scut., p. 94.

This species is very common at Darwin, occurring at all suitable beaches, but no specimens of large size were seen. The largest one taken was found at Quail Island, and is 63 mm. long by 66 mm. wide. In a series from Lindeman Island on the Barrier Reef there is a nearly circular specimen, 96 mm. in diameter, much the largest example of *placenta*, that I have seen or found recorded though Mortensen has reported a much larger specimen of the New Zealand species, *zelandiae* (Mortensen, 1921, p. 183).

At West Point, Port Darwin, some time was spent watching the movements of Arachnoides while the tide was out. They were abundant in the very fine somewhat muddy sand there, well above low water mark but only where the sand was wet. They wander aimlessly just below the surface, leaving quite a noticeable trail, approximately the width of the animal. They do not travel with any relation to the tide line but twist and turn in their course, even crossing and recrossing their own trail. The most active move 2–3 feet during the tide interval but most individuals do not travel that far. The color of these specimens was uniformly gray-purple, most of the purple disappearing in dried specimens.

Captain Bardwell found this species at Augustus and Champagay Islands and sent a dozen fine specimens, 60–75 mm. in diameter. They are relatively heavy individuals and their color, as dried, is more or less yellow-brown with a distinctly greenish cast. They thus look rather different from the gray Quail Island specimens but many individuals from West Point approach them in color.

Altogether there are 128 specimens at hand from the following places:
Queensland: Great Barrier Reef, Lindeman Island, sand beach, north side. M. Ward leg. et don. 8 specimens.
Northern Territory: Darwin, West Point, June 25, 1929. 27 specimens, small.
Darwin, Casuarina Beach, June, 1929. 76 specimens, young, many bare.
Darwin, Quail Island, July 7–9, 1929. 5 specimens.
Western Australia: Augustus and Champagay Islands, October, 1933. Beresford E. Bardwell leg. 12 specimens.

ARACHNOIDES TENUIS[1] sp. nov.

Plate **27**, figs 3–4

Test 48 mm. long, 49 mm. wide and only 5 mm. high, rather delicate; with very thin flat margins; test highest just in front of apical system; oral surface flat or barely concave. Petals concealed by the dense coat of spines but in a bare test of the same size, the petaloid area is 25 mm. in diameter and the approximately equal petals are about 10 mm. long, 7.5 mm. wide at tip, with interporiferous area there 5 mm. across; petal III is distinctly narrower than the others. Ambulacral furrows are conspicuous from margin, well into petals. Periproct on the dorsal surface, rounded triangular, about 1 mm. in diameter, its distal margin a full 3 mm. from test margin.

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[1] *tenuis* = slender, delicate, in reference to the character of the test as compared to *A. placenta*.

Peristome central in position, about 1.5 mm. in diameter; circle of surrounding oral plates very small only 6 mm. in diameter. Ambulacral furrows conspicuous but no furrow in the posterior interambulacrum. Only 1 pair of interambulacral plates on oral surface of test at margin in each interradius, as a rule, but in some interambulacra of some specimens, a second plate occurs on one side of the area. Spines very numerous and small; tuberculation of test correspondingly fine. No pedicellariae detected. Color dark-brown with a purplish cast, the ambulacra darker than the interambulacra both above and below.

Holotype, M. C. Z., no. 7204, from sand of "creek" bed near mouth of Barred Creek, north of Broome, W. A., September, 1929.

The dark color of this specimen is not typical but all of the few living adults taken, show a similar contrast in color between ambulacra and interambulacra; none are as dark as the holotype. The difference between the Arachnoides of Broome and those we had collected at Darwin was noted with the first bare tests picked up. The conspicuously supramarginal periproct and the much more delicate test made us feel sure it was a different species. But living adult specimens were very hard to find and specimens of Arachnoides were almost never dredged. At some places the dead tests are very abundant and there, living young individuals (30 mm. or less in diameter) were sometimes fairly common, but being buried in mud were hard to detect. At Cowan Creek, southwest from Broome, the dead tests occur in enormous numbers; for a long distance eastward from the mouth of the creek, a bank extends near tide-mark which is a solid mass of these tests, nearly all of moderate or small size; I calculated there were more than fifty million tests in that one area!

It is interesting to note that this western Arachnoides approaches the New Zealand species (*zelandiae*) in several particulars but differs in the arrangement of the oral interambulacral plates; the very small oral ring is also a notable difference. From *placenta, tenuis* differs markedly in the position of the periproct, in the absence of an oral groove in interambulacrum 5, in the very small oral ring and in the much more delicate test.

The 27 specimens of *tenuis* at hand were taken at the following points:

Western Australia: Broome, Barred Creek, September, 1929. 1 fine adult.
Broome, Entrance Point, August, 1929. 3 specimens; good, bare tests.
Broome, June, 1932, 3 specimens, 1 good adult, 1 small bare test, 1 very young.

Between Broome and Wallal, dredged in 8 fms., 1930. R. A. Bourne leg. 3 bare tests. Loan from Australian Museum.
Cowan Creek, September, 1929. 7 specimens, young.
Cowan Creek, September, 1929. 10 specimens, bare tests.

LAGANIDAE

LAGANUM DEPRESSUM

AGASSIZ, 1841. Mon. Ech., Mon. Scut., p. 110.

We did not meet with this species, but Mr. Melbourne Ward has sent three superb specimens from Lindeman Island, on the Barrier Reef. One, 63 mm. long but only 52 mm. wide, was taken "on a reef, north side of island." The others, 56 x 51 and 68 x 62 mm. were found "on the beach, on the south side of the island, at low water." All are of the heavy, thick-margined type. In color, they are essentially alike, the test being distinctly gray, the poriferous areas of the petals very dark, almost black and the dense coat of spines whitish or pale yellowish.

LAGANUM LAGANUM

Echinodiscus laganum LESKE, 1778. Add. ad Klein., p. 140.
Lagana laganum DE BLAINVILLE, 1830. Dict. Sci. Nat., **60**, p. 196.

This species was not met with in our collecting but Mr. Longman loaned me two notable specimens belonging to the Queensland Museum. Unfortunately, they have no locality label and there is no clue as to where they were taken, but they are by far the largest specimens as yet known for the species, and hence should be put on record. They are bare tests but are not bleached and show more or less clearly the dark spots so often seen in this laganid. They measure 63 mm. long by 63 wide, 8.5 mm. high, margin 7.5 mm. thick; and 65 x 62 mm. with height and margin as in its fellow.

PERONELLA LESUEURI

Plate **15**, fig. 3

Laganum lesueuri AGASSIZ, 1841. Mon. Ech., Mon. Scut., p. 116.
Peronella lesueuri A. AGASSIZ, 1872. Rev. Ech., pt. 1, p. 148.

This is a very common laganid on the Australian coast ranging from southern Queensland, northward and westward to Darwin and Broome, and thence southward to Fremantle and even to Albany (see Döderlein, 1914, p. 490). Only fragments were found in the region of Darwin, but at Broome, *lesueuri* is very frequently taken when dredging. We did not find it along shore. The specimens at hand range in size from 11 x 10 mm. to 157 x 136. In life the color is quite distinctive ranging from old rose to Indian red; unfortunately the color is fugacious and is seldom retained in any considerable amount even by carefully dried material; such specimens are commonly brown or yellowish of some shade. Genital pores are late in appearing and may still be wanting even in specimens exceeding 60 mm. in length. There is so much diversity in the form of the test that I quite agree with Mortensen (1918, p. 14) regarding the worthlessness of my supposed species, *Peronella aphnostina* (1914, p. 167); it is merely an extreme variant.

Among the subfossil echinoid fragments collected by Mr. Glauert at the salt lake on Rottnest Island are a number which undoubtedly represent this species. As it lives in considerable numbers in the channel between Rottnest and Fremantle, this occurrence as a subfossil in the vicinity is quite natural.

Aside from fragments, there are 41 specimens of *lesueuri* at hand:

Queensland: Great Barrier Reef, Lindeman Island, 1934. M. Ward leg. et don. 4 specimens, young.

Northern Territory: Darwin, Quail Island, July 7–9, 1929. Fragments picked up on beach.

Western Australia: Augustus and Champagay Islands, October, 1933. Beresford E. Bardwell leg. 4 specimens.

Broome, Pearl Shoal, September 12–14, 1929. 3 specimens, half-grown.

Broome, various places in Roebuck Bay or vicinity, June, 1932. 15 specimens, adult, young and very young.

Fremantle, near Garden Island, 3–5 fms., October, 1929. 10 specimens, adult and young, 4 bare.

Rottnest Island, salt lake, Quaternary deposits. L. Glauert leg. Fragments.

PERONELLA ORBICULARIS

Echinodiscus orbicularis LESKE, 1778. Add. ad Klein, p. 144.
Peronella orbicularis A. AGASSIZ, 1872. Rev. Ech. pt. 1, p. 149.

This species is also common on the tropical coasts of Australia and its bare tests are continually washed up on the beaches. Living specimens are seen less frequently but we dredged many at Broome. The nearly circular ambitus, presence of genital pores even in specimens 10 mm. long, and the short, wide, pointed petals distinguish *orbicularis* from small specimens of *lesueuri* quite readily. The largest specimen in the present series is 37 x 35 mm. but very few are over 30 mm. long. The living specimens show considerable diversity of color but the test is commonly more or less rosy red. If the spines are white or colorless, the whole animal is rose-red or pink but if the spines are brown of some shade the red may be more or less masked. Dried specimens are commonly yellow-brown, purplish-brown, green, greenish-yellow or reddish of some shade, sometimes a very distinct rose-red. Very small specimens are usually pale yellow or white.

The 69 specimens at hand are from the following places:

Northern Territory: Darwin, Quail Island Beach, July 7–9, 1929. 16 specimens, bare tests.
Western Australia: Augustus Island, October, 1933. Beresford E. Bardwell leg. 3 specimens, adult.
Broome, August, 1929. 2 specimens, young.
Broome, June, 1932. 25 specimens, adult and young.
Broome, June, 1932. 18 specimens, adult and young, bare tests.
Between Broome and Wallal, 1930. R. A. Bourne leg. 4 specimens, young. Loan from Australian Museum.
Shark Bay. 1 specimen, bare test. Loan from Western Australian Museum.

PERONELLA PERONII

Laganum peronii AGASSIZ, 1841. Mon. Scut., p. 123.
Laganum (Peronella) peronii GRAY, 1855. Cat. Rec. Ech. Irreg., p. 13.

Only 2 specimens of this laganid are at hand. The smaller which was dredged by Professor T. T. Flynn in 40–80 fms. off Schouten Island, Tasmania, is remarkable for the diversity of its genital pores. Unfortunately, it is a somewhat water-worn dead test, only 21 x 20 mm., and it is not possible to make sure whether the apparent genital pores are really such; in interambulacrum 1 is a very minute pore about 3 mm. from apex of test; in 2, is a very large pore close beside petal III and a little more than 3 mm. from apex; it is probable that this pore which is .60 mm. in diameter has been artificially enlarged; in area 3, no genital pore can be detected; in area 4 also, there is no pore but in petal IV, almost 5 mm. from apex and just inside the posterior poriferous area there is a very definite pore; finally in area 5, which of course should have no pore, is a conspicuous pore 4.5 mm. from the apex.

The larger specimen is also a bare test, not water-worn and dark brown in color; the 4 genital pores are normal, 6–7 mm. from the apex. But the specimen is notable as the largest yet recorded, 45 x 43 mm.— just a trifle larger than one in the British Museum. It belongs to the Queensland Museum but is from an unknown locality.

PERONELLA TUBERCULATA

MORTENSEN, 1918. K. Svenska Vet.-Akad. Handl., 58, no. 9, p. 16.

This species was described from "a single not very finely preserved specimen" collected on the beach at Broome. It proves to be a very common "sand-shilling" in that region and is often taken along the beach or dredged in shallow water. Whether it actually occurs at the same spots as *orbicularis*, I am not certain, but they were sometimes taken in the same dredge haul. Adult specimens of the two species are readily distinguished by the shape of the petals and by the much more evident oral ambulacral grooves in *tuberculata*. It should be noted, however, that some specimens of *orbicularis* show very evident ambulacral grooves extending outward from the mouth. The glassy tubercles of *tuberculata* are also a noticeable feature in large specimens and the coloration of the two species is different. Mortensen makes no reference to the color of his type specimen but in life *tuberculata* is purplish-gray with the poriferous area of the petals distinctly darker; the lower surface has more evidence of purple than the upper; some specimens were distinctly brown, almost fawn-color but it is not impossible that these were already dead when dredged. In alcohol, these laganids, like other clypeastroids, turn a bright grass green; in formalin, or Epsom salts or even in simple fresh water, they turn green usually of a somewhat darker shade. There is no hint of red of any shade in the living animals. Dried specimens show great diversity of color according to the amount of green retained; a few specimens retain the green especially on the poriferous areas conspicuously but generally it is evident only as a greenish-yellow tint retained by the spines, not often by the test, which ranges from light fawn-color to rather dark brown. Young individuals (under 20 mm.) are very light yellowish or cream color and preservation affects their color but little. Of course, very young specimens cannot always be distinguished from young *orbicularis*, but the latter show genital pores much earlier than young *tuberculata*.

The form of the test in *tuberculata* shows as great diversity as the color of dried specimens. The holotype was 43 x 41 mm., the width being thus 95% of the length; the ambitus was rounded decagonal or almost circular. The present series shows that the majority of adults are not often so nearly circular; the width of the test is generally about .90 of the length and the ambitus is correspondingly elliptical. But there are some individuals markedly longer than wide (44 x 37 mm. or even 31 x 24) and these tend to be rounded pentagonal in form. At the other extreme are those in which the breadth equals the length (42 x 42) or nearly so and these are usually quite evidently rounded decagonal.

All of the 136 specimens at hand were collected in Roebuck Bay or southwestward therefrom as far as Lagrange Bay. They range in size from 5.5 x 4.5 to 46 x 44 mm.

FIBULARIIDAE

Fibularia volva

Agassiz and Desor, 1847. Ann. Sci. Nat. (3) 7, p. 142.

It is not surprising that this little Echinoid proved to be by no means rare in the vicinity of Broome, for it has long been known from northern Australia, as well as from various points on other coasts of the Indian Ocean. But the bare tests are much more common than the living animal and only two of the specimens at hand are covered with spines. These agree well with the one from Cape Jaubert described by Mortensen (1918, p. 18). They are about 8 mm. long, 6 mm. broad and 5–6 mm. high; one is a pale cream color with 20 radiating lines of a darker shade; there are two such lines in each ambulacrum and two in each interambulacrum. These lines are regarded by Mortensen as made up of tube-feet but I cannot satisfy myself on this point. The larger specimen is a yellowish cream color with the radiating lines bright yellow. In life both of these specimens were pale brown. The smallest of the bare tests is 3.25 x 2.5 x 1.6 mm.; the largest is 10 x 8 x 6 mm. All the specimens examined have 8–10 or possibly more madreporic pores; as the same is true of a Red Sea specimen, I am inclined to agree with Mortensen that this is a valid specific character.

Besides the 6 specimens at hand from 5–7 fms. of water near Broome, there is a typical bare test from "Middleton Beach, near Albany, January, 1929, collected by Master Miles Clark." This specimen measures 8.5 x 5 mm. and is somewhat water-worn. It was given to me by Professor E. W. Bennett. The occurrence of this species so far south as Albany is quite surprising.

ECHINOCYAMUS PLANISSIMUS[1] sp. nov.

Plate **27**, figs. 5–8

Test of diverse form but always very flat, though the distal part of the whole petaloid area is sunken a trifle below the slightly thickened margin of the test; apical system central and slightly elevated. There is thus a noticeable resemblance in test form to *Clypeaster reticulatus.*

Holotype, 7 mm. long, 6 mm. wide and about 1.5 mm. thick; largest bare test (Pl. 27, figs. 5 and 6), 8 mm. long, 7.25 mm. wide, 1.5 mm. high, the petaloid area conspicuous, 5 mm. long by 4.5 mm. wide. Small specimens are narrower and more elongated (Pl. 27, figs. 7 and 8), the extreme being one which is 5.5 mm. long, 4 mm. wide at posterior end of petaloid area and at anterior end only 3 mm. In the largest bare test, petals I and V have 7 or 8 pore-pairs in each of the poriferous areas which are 2 mm. long and markedly converging; petals II and IV are distinctly shorter, with only 6 or 7 pore-pairs on each side and the blunt tip is nearly closed; petal III has distinctly curved poriferous areas with 8 or 9 pore-pairs; the petal is widest near the middle but is broadly open at tip. Genital pores 4, larger than the petal pores; madreporic pores about 7. Test closely tuberculated, the primary tubercles small, about equal to the petal pores.

Oral surface distinctly concave, with the mouth quite sunken, posterior to the center; diameter of peristome is about 1 mm. Periproct not half so large as peristome, distant about its own width from margin of test, and more than twice that distance from margin of peristome. A prolonged search discovered only a single pedicellaria; a tridentate with valves .10 mm. long occurred on the periproct.— Color in life pale brown, which preservation and drying change into a yellow-brown, the interambulacra being evidently lighter and more yellow than the ill-defined ambulacral areas; orally this is more evident than dorsally and near the peristome the greenish tint of the ambulacra is very evident in the dry holotype. The bare tests are, as usual, more or less nearly white.

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[1] *planissimus* = most flat, in reference to its extreme flatness.

Holotype, M. C. Z., no. 7234, from Pearl Shoal, Broome, W. A., 5–7 fms., broken shell bottom. September 26, 1929.

The holotype was the only living specimen secured but 6 bare tests were taken on Pearl Shoal during September. In 1932, only 2 small bare tests of Echinocyamus were taken during the month of dredging. Probably the species is not so rare as this record indicates; its small size permits its being washed out through the meshes of the dredge net as the latter is drawn to the surface.

This species resembles *E. platytatus* in form but the dorsal surface is flatter and the petals and petaloid area are quite different. There is some resemblance in these latter respects to *provectus* but the general shape of the test and the position of the periproct prevent any confusion.

ECHINOCYAMUS PROVECTUS

DE MEIJERE, 1903. Tijdschr. Nederland Dierk. Ver., ser. 2, 8, p. 6.

Among the specimens given to me at Hobart by Professor T. T. Flynn is the bare test, now badly broken, of an Echinocyamus which he himself dredged in 40–50 fms., off Schouten Island, southeastern Tasmania. Before critical study the test measured 7 mm. long, 6 mm. wide and a little more than 2 mm. high. The anterior end was rounded, the posterior truncate. The height of the test led to the opinion that the specimen represented a species of Fibularia but finally the test was opened and it was demonstrated that it is an Echinocyamus. Comparison with specimens of *E. provectus* from 41–50 fms., off Cape Three Points, New South Wales, leaves no doubt this test should be referred to the same species, the range of which is thus extended far to the southward. As the original specimens were taken in the East Indies, it is not unlikely that comparison of adequate material from southeastern Australia with East Indian specimens would reveal differences at present unrecognized.

SCUTELLIDAE

ECHINODISCUS AURITUS

LESKE, 1778. Add. ad Klein, p. 138.

It was a real surprise to find this species at Broome, as it has not hitherto been known from the Australian coast. The only adult specimen taken was found at extremely low tide, on September 23, 1929. It lay just below the surface of the sand near the far end of the jetty. The color in life was deep yellow-brown but in the dry specimen there is an evident purple tint. The specimen measures 138 x 134 mm.

Earlier in the month, a bare test was found on the shore at Cowan Creek, Lagrange Bay, and two small specimens (32 x 31 and 85 x 82 mm.) were dredged outside the bay, but in the same region. These young specimens were distinctly red-violet and on drying retained (and still show) this bright color; close examination of the larger specimen showed, however, that the spines turned green while the test itself underwent no essential change; the green color has, however, largely faded away.

In 1932, 5 specimens were dredged along the coast south of Broome. Of these, 2 are very small (8 x 8 and 11 x 11.5 mm.) and bright red-violet in color; the larger shows two very shallow posterior notches, indicating the position of the marginal slits, but in the smaller specimen, the posterior margin is not even notched. The three larger specimens are about 120 mm. long but still retain, to a greater or less extent, the bright violet color, at least so far as the test is concerned. All three of these specimens were badly damaged in the collecting. Apparently the animal lies so near the surface of the muddy sand that the dredge bar breaks through the test before the animal is dislodged from the sand.

ECHINONEINAE

Echinoneus cyclostomus

Leske, 1778. Add. ad Klein, p. 109.

This tropicopolitan echinoid is common at Neds Beach, Lord Howe Island, where it lives in the sand under stones (often more or less imbedded in coralline algae) between tide marks. We secured a fine series of specimens of which 38 are at hand. They show extraordinary diversity of form and many are markedly deformed, suggesting that they move little or not at all after once settling down under the rock or among the rocks where they live, and that the pressure of the rock has prevented normal symmetrical development. One striking deformity does not lend itself to so simple a solution; the test is 36 mm. long, 29 mm. wide and 15 mm. high, with an elliptical ambitus which is only slightly asymmetrical, but the apical system is sunken in a sharply funnel-shaped pit 6 mm. deep. The most elongated specimen is 32 mm. long by only 22 mm. wide, while the other extreme is represented by a very symmetrical specimen 29 x 26 mm. The smallest specimen is 17.5 x 13 mm. while the largest is 44 x 36 x 19; this specimen when living was 45 x 38 x 20 mm. A specimen 2 mm. shorter than this one is a millimeter wider and 4 mm. higher. As these specimens equal in size the largest one hitherto known (in the British Museum and labelled as from the West Indies), it would seem that conditions at Lord Howe are very favorable for Echinoneus. In life the color is a rich brown-red or a lighter shade of brown. The dried specimens show considerable diversity ranging from a pale yellow-brown to deep red-brown.

A specimen much larger than any of these from Lord Howe has been most generously presented to the Museum of Comparative Zoölogy by the Australian Museum, and deserves a special paragraph. It was one of three large specimens taken by Mr. Melbourne Ward, in July, 1929, at Nor'west Islet, Capricorn Group, Queensland. It is an unusual blackish-brown in color and is quite deformed, apparently by long continued pressure on the upper half of interambulacrum 2. But it is 51 mm. long, 43 mm. wide and 29 mm. high. Seen from the oral side, the ambitus is not noticeably asymmetrical but is oval with the anterior end the narrower and the posterior end almost truncate. This gift was accompanied by the magnanimous note: "No better repository than your Museum."

NUCLEOLITIDAE

APATOPYGUS OCCIDENTALIS[1]

Plate **28**, figs. 1–3

Test rather low, 17 mm. long, 13 mm. wide, and 7 mm. high. Abactinal system very small, less than 6 mm. from anterior end of test, about 1 mm. long, scarcely as much in width, with very few (possibly 10), minute madreporic pores and 4 large genital pores placed close together, the posterior pores distinctly larger and slightly farther apart than the anterior.

Petaloid area large, occupying most of the upper surface of test; petals I and V long, about 9 mm., the poriferous areas, each with about 24 pore-pairs, diverging but little except at the very beginning, nearly equal or the anterior a trifle longer; petals II and IV much shorter, about 5.5 mm., with 18 or 19 pore-pairs in each of the poriferous areas, which are nearly equal or the posterior a trifle longer; petal III similar to II and IV in size, and form, and in number of pore-pairs. Tuberculation of test close and uniform, the primary tubercles occurring about 9 to a square millimeter; there are at least 2 fairly complete series within each petal.

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[1] *occidentalis* = of the west, in reference to the region inhabited by this species, in contrast to the range of the only other member of the genus, *A. recens* of New Zealand.

Periproct rather small, about 2 mm. wide and little more than 2.5 mm. long; it occupies a sloping position on the oblique wall of the anterior end of the dorsal furrow; its posterior margin is about 2 mm. from the end of the test.

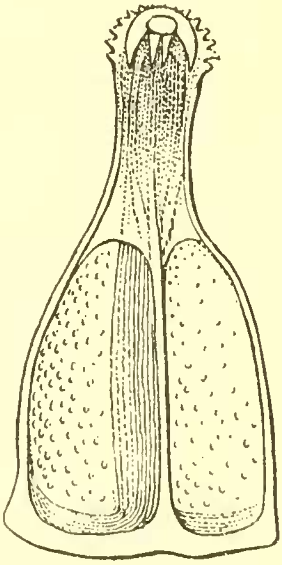

Fig. 36. Apatopygus occidentalis. Inner view of valve of globiferous pedicellaria. x 300.

Oral surface of test markedly sunken in an indefinite longitudinal depression, 3–4 mm. wide near mouth but broadening out and fading away posteriorly; anteriorly it extends to within about 2 mm. of the test margin. Peristome deeply sunken, almost circular, about 2 mm. in diameter. Spines longest about the peristome, shortest in the bottom of the dorsal furrow, similar to those of *A. recens*. Pedicellariae of at least two kinds occur, ophicephalous and globiferous; no tridentates were detected; the ophicephalous are not essentially different from those of *A. recens* but the globiferous (fig. 36) are distinctive; in size, form, and conspicuous appearance, these pedicellariae resemble those of *recens* but the valves terminate in 2 very large lateral teeth with only 2 smaller teeth between them.

Color in life, cream-color with conspicuous heads of globiferous pedicellariae, blackish-brown; on preservation a distinct green color appeared in the spines but the dry specimen shows scarcely a tinge of green; the test is nearly white, the spines brownish-yellow, the globiferous pedicellariae a darker dull brown.

Holotype, M. C. Z., no. 7246, dredged in about 10 fms. between Rottnest Island and Fremantle, October 19, 1929.

The taking of this specimen was one of the most extraordinary incidents of dredging in my experience. Returning from Rottnest to Fremantle, we made four hauls of the dredge but, probably due to the speed of the boat, the net was on the bottom apparently but little. In the first haul, there was only a single sea-star but that was a new species of Archaster previously taken at Broome and not expected near Fremantle; the second haul yielded a single small specimen of the new clypeastroid, *Hesperaster arachnoides;* the third haul brought up a single specimen also, but that was the fine adult Hesperaster which is the holotype of the species mentioned; finally the last haul seemed to result in nothing but an empty net. As it was getting late, we hastened onward to Fremantle. Regretful at the small return for our efforts, I began looking the net over very carefully, hoping some brittle-stars might have been entangled in the meshes. I found none, but to my surprise and delight I found caught between the net and the frame of the dredge, the little nucleolitid which proved the occurrence of an undescribed Apatopygus in Western Australian waters. Of course, the little specimen from off Bunbury, in 22 fms., which I discussed in 1928 (p. 479) under the name *A. recens* (Milne-Edwards) is really *occidentalis;* the form of the test and the globiferous pedicellariae prove that beyond question.

Thanks to the kindness of my good friend, Dr. Mortensen, a specimen of *A. recens* from New Zealand, just 17 mm. long is at hand for comparison with the holotype of the Western Australian species. The difference in the shape of the test is striking, the New Zealand specimen being almost 15 mm. wide, with a periproct 4.5 mm. long and 3 mm. wide; the lower surface is depressed around the peristome but not in the way it is in *occidentalis* and the peristome itself is wider than long, not circular. A surprising feature is the absence of genital pores, which are very prominent in the western species; perhaps this indicates that *occidentalis* is a smaller form and never attains to the size of *recens.* The abactinal system is much larger in the New Zealand species and there are many more madreporic pores. The petals are conspicuously longer in *occidentalis,* with more pore-pairs, and the tuberculation of the test is much closer and more uniform. The difference in the globiferous pedicellariae has already been mentioned but if these disappear in adult specimens as they seem to often in *recens,* the character is not very useful to the taxonomist and of course it is worthless when only bare tests are in hand. Very likely some of the differences between the two specimens compared above will prove to be inconstant, but there is no doubt of their being distinct species.

The discovery of this genus off Bunbury by Dr. Verco many years ago (see Clark, 1928, p. 479) was a most interesting addition to the Recent fauna of Australia, since it had been reported from the Tertiary rocks of that continent long before. This additional specimen from Fremantle is of particular importance as showing that the living species of Western Australia is not only quite different from the Tertiary species but from the Recent species of New Zealand.

CASSIDULIDAE

ECHINOLAMPAS OVATA

Echinanthus ovatus LESKE, 1778. Add. ad Klein, p. 127.
Echinolampas ovata DÖDERLEIN, 1906. "Valdivia" Ech., p. 240.

As this species has long been known from Western Australia, it is not surprising that we occasionally took specimens in the vicinity of Broome, but bare tests or fragments thereof were more common than living specimens. The series at hand ranges from a very young specimen, living when taken, 13 x 10 x 7 mm. to the bare dead test of an adult, 67 x 56 x 34 mm. None of them are notable in any way. In life the color ranged from a very light wood brown in the smallest specimen to a very deep chestnut brown or dark yellowish-brown in the adults. The dried specimens have undergone little change but are not so dark colored as in life and some have a distinctly reddish-brown tinge.

The 14 specimens before me were taken at the following places:

Western Australia: Augustus Island, October, 1933. Beresford E. Bardwell leg. 4 specimens, 2 bare.
Broome, Pearl Shoal, 5–7 fms., September, 1929. 2 specimens, 1 very young, 1 a large bare test.
Broome, near Lagrange Bay, September, 1929. 2 specimens.
Broome. Beresford E. Bardwell leg. et don. 1 fine adult.
Broome, 1930. R. A. Bourne leg. 1 small adult. Loan from Australian Museum.
Broome, June, 1932. 4 specimens, 1 adult, 2 young and 1 bare test.

PALAEOPNEUSTIDAE

ARCHAEOPNEUSTES NIASICUS

Palaeopneustes niasicus DÖDERLEIN, 1900. Chun's Aus. Tief. Welt., p. 360.
Archaeopneustes niasicus KOEHLER, 1914a. Ech. Indian Mus.: Spat., p. 54.

The discovery of this remarkable sea-urchin off southeastern Australia is not only an interesting addition to the fauna of that continent but emphasizes anew how much we still have to learn about the echinoderms of the surrounding seas.

The two specimens at hand were taken by a trawler in 70 fms. off Cape Everard, Victoria, and were loaned to me by the Australian Museum. As there is a fine cotype of Döderlein's in the M. C. Z., there has been no difficulty in satisfying myself that these Australian specimens are really identical with those taken by the "Valdivia," for they measure 142 x 110 x 71 mm. and 147 x 116 x 79 mm. The primary spines are correspondingly stouter but unfortunately most of them are missing or broken; the only complete one is 25 mm. long and 1.5 mm. in diameter at the base. The dry specimens are deep brown with a very evident purple tint on the oral surface. The larger spines are dirty whitish, the smaller, almost translucent.

The failure of the "Siboga" to take even one specimen of Archaeopneustes in all her East Indian dredging, and the similar failure of the "Endeavour" to take a specimen in all her collecting off southeastern Australia suggest that this spatangoid is both rare and local.

HEMIASTERIDAE

PROTENASTER AUSTRALIS

Desoria australis GRAY, 1851a. Ann. Mag. Nat. Hist. (2) 7, p. 132.
Protenaster australis POMEL, 1883. Class. Meth. Ech., p. 36.

The discovery of this apparently rare spatangoid by Professor E. W. Bennett at the very southwestern corner of the continent is of great interest, especially since the specimens he has sent are not bare, bleached tests, as is usual, but still possess a considerable part of their normal coat of spines and even some globiferous pedicellariae. Most of the spines are more or less curved and the small ones are thickened or widened at tip. The globiferous pedicellariae occur on the dorsal side of the posterior half of the test. They are thickly encased, both stalk and head, in black glandular tissue; the black coloring matter also stains the adjoining test and spines, making irregular blackish spots wherever a globiferous pedicellaria is located; whether this would be so in life or is the result of drying the specimens, there is no means of knowing. In structure these pedicellariae are like those of Hemiaster (see Mortensen, 1907, p. 100) but the valves are longer and much narrower at base and the tubular blade has a much greater diameter; moreover, the opening has a dozen or more teeth on the upper margin and sides. In the largest specimen there are only about eight of these pedicellariae present and the same is true of the smallest one, but in an individual 40 mm. long there are twice as many. The range in size of these specimens is from 20 x 17.5 x 12 mm. to 51 x 45 x 30 mm., but the 4 genital pores are developed in all. The largest specimen is uniformly dull dark brown, with the black spots of the globiferous pedicellariae not very conspicuous; there is no trace of lavender or purple in the color. The other specimens are yellowish-brown with many small spines of a darker shade and the black pedicellarian blotches look big and conspicuous. This brown coloration with a total lack of the purple, which is usually evident on the bare tests of Protenaster from Tasmania and Victoria, suggests that the western form is a different species but there is no structural feature which bears out this idea.

The 5 specimens were taken as follows:

Western Australia: Ellen Brook Beach, drift material, January, 1930. E. W. Bennett leg. et don. 4 specimens, young and small adult.
Hamelin Bay, near Augusta, drift, January, 1930. E. W. Bennett leg. et don. 1 specimen, adult.

HYPSELASTER DOLOSUS[1] sp. nov.

Plate 28, figs. 4–7

Test wide and high, with the ambitus elliptical but notched in front and truncate behind; length 46 mm., width 40 and height just back of apical system, 32 mm.; 10 mm. from the anterior end the height is only 20 mm. Apical system distinctly posterior, fully 25 mm. from anterior end of test; genital pores 2, .75 mm. in diameter and 2 mm. apart. Ambulacrum III, 6 mm. broad, deeply sunken, 3–4 mm., and causing a notch in anterior margin about 5 mm. wide and nearly

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[1] *dolosus* = deceptive, in reference to the resemblance to *Schizaster lacunosus*.

2 mm. deep; poriferous areas narrow, straight, in parallel single series. Petals I and V, about 9 mm. long by 3.5 mm. wide, with about 20 pore-pairs on each side; not markedly divergent, only about 7 mm. apart at tip; and separated proximally by the madreporite. Petals II and IV, prettily curved; each starts just in front of a genital pore, running outward, but quickly curving forward and then curving abruptly outward again, so the distal tips are 22 mm. apart; each is about 16 mm. long by 3.5 mm. wide, and has some 27 pore-pairs on each side; elevated ridges between these petals and ambulacrum III are conspicuous proximally, some 2 mm. high and 2–3 mm. wide. Peripetalous fasciole very wide and conspicuous, narrowest (1 mm.) in interambulacra 2 and 3 and widest (3.5 mm.) at tips of petals II and IV. There is no trace of any other fasciole, the latero-anal fasciole being wholly wanting. The whole petaloid area is about 35 mm. long by 29 mm. wide near anterior end. Periproctal area flat and nearly vertical but lower end projects very slightly; periproct 6.5 mm. high by 3 mm. wide. Sternum broadly triangular, about 25 mm. long and 20 mm. wide at the rear end, closely covered with tubercles which bear the usual curious spatulate spines. Peristome not at all sunken, 6.5 mm. wide and some 2 mm. long, with labrum projecting quite noticeably.

Spines relatively long, especially at the anterior end, along the sides of the petals and on the sternum; those near the ambitus in ambulacra II and IV are 5–7 mm. long, slender and pointed. Pedicellariae very scarce, one tridentate and one globiferous (on the periproct) being all that were found. These are much like those of *Ova canaliferus* (see Mortensen, 1907, pl. XIV, figs. 8 and 12) but the valves of the globiferous pedicellaria seem to have but one tooth on each side of the small terminal opening much as in figure 4 of Mortensen's plate, from an unidentified schizasterid from the Arafura Sea. The shape of the valve in figure 4 is, however, quite different from that in the present species.

Color in life, light brown, usually with a grayish tint but sometimes yellow-brown or reddish-brown; dried specimens undergo little change.

Holotype, M. C. Z., no. 7255, Broome, jetty flat, September, 1929, a bare test.

The selection of a bare test for the holotype of this species is obviously objectionable but the specimens with spines are both unsuitable. Since neither color, spines, nor pedicellariae are at all distinctive, their absence in the holotype is not important. One of the specimens with spines lacks the whole of the lower surface, while the other is a curiously deformed individual with a greatly depressed test; it is 49 mm. long by 46 mm. wide but the maximum height at the posterior end is scarcely 25 mm. Of the remaining specimens, 4 are perfectly bare tests while 5 have some spines, chiefly along the furrow in ambulacrum III or on the margins of the petals. The deformed individual is the largest, while the smallest is a specimen scarcely 20 mm. long, 17 wide and 13 mm. high. There is not much diversity of form but some individuals are evidently narrower than the type; thus a specimen 42 mm. long is only 30 mm. wide and another scarcely 36 mm. long is just 30 mm. wide. The latter is 26 mm. high (v.d. = .72 h.d.) while a specimen 39 mm. long is only 25 mm. high (v.d. = .64 h.d.); this is the rather limited range in this character.

All of the 12 specimens, save one, were taken on the flat near the jetty at Broome. They live buried in the mud to a depth of at least 4–6 inches and were very difficult to locate. But they must be common, for the bare tests or recently dead and partly bare specimens were constantly washed up on the beach. The only specimen not from Broome was found by Captain Bardwell at Augustus Island in October, 1933.

Until critical examination of these spatangoids was made, they were supposed to be *Schizaster lacunosus* but the constant absence of the latero-anal fasciole seems to necessitate placing the species in Hypselaster, although the deeply sunken ambulacrum III cries out against that. Dr. Mortensen has kindly suggested that perhaps this is the long lost *Schizaster jukesii* of Gray, but Gray's description of the peripetalous fasciole and the position of the vertex, and his single figure showing the shape of the test seen from below, prevent my accepting this suggestion. On the whole it seems best to treat these specimens as an undescribed Hypselaster.

MOIRA STYGIA

Moera stygia A. AGASSIZ, 1872. Bull. M. C. Z., **3**, p. 58.
Moira stygia A. AGASSIZ, 1872. Rev. Ech., pt. 1, p. 147.

It was one of the disappointments of my visits to Australia that we failed to find this interesting spatangoid, of which few specimens exist in museums. There are 3 specimens before me, each of which deserves a word.

The smallest is 34 x 28.5 x 24 mm. with a nearly complete coat of spines; the color is a light yellowish-brown. It was given to me by Captain Beresford Bardwell at Broome in 1932. He found it while collecting shells at very low water on a bank in Roebuck Bay about a mile south of the jetty at Broome. The occurrence of Moira on the northwest coast of Australia is notable indeed.

Equally notable, and much more surprising, is a bare test, very pale brown or brownish-white in color, 37 x 33 x 29 mm. from Port Willunga, South Australia, given to the M. C. Z. by Mr. W. J. Kimber. It is accompanied by the note: "Very uncommon." That Moira should occur on the southern coast of Australia is certainly astonishing. This record extends the range of the species (and of the genus too) fully 1400 miles, more than half of which is an extension to the south.

The third specimen is the largest as yet recorded. It is 49 mm. long, 44 mm. wide and 37 mm. high. It still retains a considerable part of its coat of whitish or translucent spines, but the general color is a light yellow-brown. It was taken in Moreton Bay, by Dr. F. W. Whitehouse, and belongs to the Queensland Museum.

SPATANGIDAE

Brissopsis luzonica

Kleinia luzonica Gray, 1851a. Ann. Mag. Nat. Hist., (2) **7**, p. 133.
Brissopsis luzonica A. Agassiz, 1872. Rev. Ech., pt. 1, p. 95.

This species seems to be not uncommon near Lindeman Island, Great Barrier Reef, for Mr. Melbourne Ward has dredged it on muddy bottom in shallow water there. This is a noteworthy extension southward of its known range. The half dozen specimens at hand are all young, ranging in size from 16 x 13 x 9 mm. to 36 x 30 x 21 mm. They are of a light grayish-brown color. We found no Brissopsis on the north or west coasts.

Rhynobrissus hemiasteroides

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 211.

The discovery of this curious spatangoid at Broome was most unexpected. The lone holotype was taken by the "Challenger" at Tahiti. Subsequently the species was discovered on the eastern coast of Australia. In 1918, Mr. D. Thaanum found it was common near Lahaina, Maui, in the Hawaiian Islands, but he took only young specimens. That it should occur at Broome seems almost incredible but the specimens in hand show no character by which they can be distinguished from the Hawaiian specimens, save their larger size and much darker color. Very small specimens, however, dredged at Broome are very light brown or nearly white, as light as the Hawaiian specimens. It is interesting to note that in the smallest specimens from Hawaii, 15 mm. or less in length, the anal and subanal fascioles are more or less fused but with growth they become quite separate and in the large specimens from Broome there is a strip of normally tuberculated test a millimeter wide between them. These specimens are very dark brown in color but one, which is partly denuded, shows the test is a bright yellow brown above and dull greenish-brown below. The Broome specimens range from 9 x 7 x 5 mm. to 16 x 10 x 9 mm., and from 29 x 24 x 16 mm. to 49 x 44 x 26 mm.; the last is a bare test but there is also a very fine specimen with spines, nearly as large.

Besides the specimens from Broome, I am referring to this species 2 very large specimens of Rhynobrissus from Queensland, (57 x 50 x 31 and 65 x 58 x 38 mm. — the largest yet known). They differ strikingly in one particular from the large Broome specimens but it is not impossible that this is due to their much greater size. In the Broome specimens, the anal fasciole forms an ellipse, open at the top, about 14 mm. long and 10 mm. wide; the periproct is near the center. In the large Queensland specimens, the fasciole forms an elongated oval (20 mm. long and 9 mm. wide near the top, much narrower below, and 22 x 13 mm. narrower below) well separated from the subanal fasciole, with the periproct in the wide upper portion. Thus in the Broome specimens the periproct is about its own length above the subanal fasciole while in the Queensland specimens it is more than twice its length. Should this feature hold true in smaller specimens, it would seem to warrant at least a varietal distinction.

The 9 specimens of *hemiasteroides* at hand are chiefly gifts and loans, as the following list reveals:

Queensland: Coolangatta. S. W. Winders leg. et don. 2 large specimens. Loan
from Brisbane Museum.
Western Australia: Broome, 1932. 3 very young specimens.
Broome, 1932. Captain Beresford E. Bardwell leg. et. don.
4 fine specimens, 1 a bare test.

RHYNOBRISSUS MACROPETALUS[1] sp. nov.

Plate 28, figs. 8–9

Length 56 mm., breadth 46 mm. and height 36 mm.[2] Petals but very little depressed, truncate and but slightly narrowed at tip with practically no interporiferous areas; I and V about 25 mm. long, 3.5 mm. wide or narrower proximally, slightly curved outward distally, with more than 21 (probably 25 or more) pore-pairs in the outer series; in the inner series the proximal pores are very small and apparently cease before the abactinal system is reached; II and IV about 20 mm. long, 4 mm. wide, abruptly narrower proximally, slightly curved forward and then outward, with 15 pairs of pores in each series. Peripetalous fasciole well developed, about 1.5 mm. wide; it terminates the posterior petals but the anterior pair do not quite reach it. Peristome 3 mm. long and about 10 mm. wide. Sternum long and narrow, from labium to subanal fasciole is 35 mm., while the width is 12–13 mm. Subanal plastron about 12 mm. high, the width apparently a little greater. Anal fasciolar area more than a millimeter above subanal fasciole, about 18 mm. high by 10 wide. Periproct relatively small, about 6 mm. high by less than 4 wide, apparently placed a little above the center of the fasciolar area.

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[1] μακρός = long + πέταλον = *a leaf*, in reference to the unusual length of the petals, for this genus.

[2] Subsequent to the taking of these measurements, an accident for which the writer was in no way responsible crushed the specimen, and necessitated the present fragmentary description.

Holotype, M. C. Z., no. 7264, from Broome, W. A., a bare test, presented by Captain Beresford E. Bardwell, in June, 1932.

Besides this now badly damaged specimen, a fragment of a somewhat larger one was dredged south of Broome in June, 1932. Although only 25 mm. long, 25 mm. wide at one end and 15 mm. at the other, this fragment contains a considerable part of petal V, as is easily demonstrated by comparison with the type specimen. When taken from the dredge it was carefully preserved as it was obviously not the petal of any spatangoid we had previously seen. It has been, therefore, a welcome surprise to be able to identify it with the remarkable Rhynobrissus given us by Captain Bardwell. The size in life of this individual, if proportions hold good, must have been not less than 70 x 58 x 48 mm., considerably larger than any individual of Rhynobrissus yet taken. The character of the petals readily distinguishes this species from any related spatangoid.

Brissus latecarinatus

Spatangus brissus var. *latecarinatus* Leske, 1778. Add. ad Klein., p. 185.
Brissus latecarinatus H. L. Clark, 1917. Mem. M. C. Z., **46**, p. 219.

This big spatangoid was met with only at Lord Howe Island, where we found it twice on the reef-flat near Mt. Lidgbird. In one case only a bare test 116 x 92 x 67 mm. was found but on April 5, a very fine living specimen, 120 x 100 x 60 mm. was dug out of the sand under a rock slab where it was buried 3–4 inches below the surface of the sand. It was pale brownish with a slight lavender tinge and there were 10–12 conspicuous but small black spots on the posterior half of the back. These indicated the position of big globiferous pedicellariae with their black glandular tissue as already referred to under *Protenaster australis*. This individual is now dry and the color is a dull reddish-brown but the black spots can still be distinguished.

EUPATAGUS DYSCRITUS[1] sp. nov.

Plate 28, figs. 10–11

Length at least 85 mm., width about 70, height uncertain but probably over 45. Test not flattened dorsally but rising to a considerable apex anterior to center, covered with very close and fine tuberculation, coarser within the petals. Peripetalous fasciole conspicuous, a millimeter or more in width. Ambulacrum III, perfectly flush with the adjoining interambulacra and scarcely delimited save by the series of coarser tubercles on the margins of those areas where they touch it; and these coarser tubercles are confined to the adapical area extending only 10–15 mm. from the apex. Petals broad and flush with the surface, only the poriferous areas being slightly depressed; I and V are 35 mm. long by 8 mm. wide, nearly closed at tip, the anterior poriferous area nearly straight with 18 pore-pairs, starting 10 mm. or more from apex (of course there are minute pores proximally); the posterior area is distinctly curved (so that the petal is widest about 9 mm. from tip) with 18 evident pore-pairs and 6 or 7 minute ones proximally; petals II and IV have about the same length and width as the posterior pair but are of different shape; they run outward and slightly forward from apex at an angle of 75–80° with the longitudinal axis; anterior poriferous area becomes evident about 10 mm. from apex, the 16 pore-pairs running thence straight for about 15 mm. when they turn very slightly backward and run thence straight to fasciole; the angle formed is barely perceptible, just enough to prevent saying that the area is straight; posterior area markedly convex with 17 pore-pairs which first appear about 8 mm. from apex; the apparent absence of pore-pairs in the proximal portion of all the petals is a conspicuous feature. Apical system very small. Number of genital pores unknown. Peristome, periproct and nearly all of oral surface missing; the fragments present indicate that the remarkably close tuberculation extended well on to the oral side. There are no large primary tubercles anywhere. On petal II and interambulacra 2 and 3 are a considerable number of spines, 2–4 mm. long, curved, slightly flattened and distinctly widened near tip but sharp-pointed. No pedicellariae were found. Color of test bright yellow-brown; of spines, white.

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[1] *δύσκριτος* = *hard to determine*, in reference to the uncertainty as to the correct generic position of this species.

Holotype, Victoria National Museum, Melbourne, no. 68686, consisting of fragments received from the Dr. T. S. Hall collection, May 19, 1921. They are unfortunately from an unknown locality but it is reasonable to assume that the specimen was found somewhere on the coast of Victoria. Curiously enough, there is in the same tray a fragment of a bleached test of a second specimen, including a complete petal V, some 30 mm. long. Whether this slightly smaller specimen is from the same locality as the type, there is no means of knowing.

That this species is more nearly related to *Eupatagus valenciennesi* than to any other Australian echinoid there can be little question but the form of the test, the absence of primary tubercles and the character of the general tuberculation lead to the conclusion that the two species are not congeneric. It seems probable that the present fragments really represent an as yet unknown genus.

GONIMARETIA INTERRUPTA

Lonchophorus interruptus STUDER, 1880. Monats. Berlin Acad. Wiss., p. 880.
Gonimaretia interrupta H. L. CLARK, 1917. Mem. M. C. Z., **46**, p. 245.

It is a matter of more than usual interest that we dredged a specimen of this very rare spatangoid off Lagrange Bay, south of Broome, W. A., in 5–7 fms., in September, 1929. To be sure, the specimen is a poor thing, a dead, bare test, semi-fossilized, more or less water-worn and marred here and there with worm tubes, and with a considerable part of the posterior dorsal surface missing. But it is unmistakable and is, of course, of great importance for the locality; the holotype in Berlin is said to be from "30 fms., West Australia," while the second known specimen, in the Museum at Adelaide, has no locality label whatever. The present specimen is 23 mm. wide and 12.5 mm. high; the length is approximately 27 mm. but may have been a trifle longer when the test was complete. The specimen is thus but little larger than the Adelaide specimen and a little smaller than the holotype. As in the latter, there are no primary tubercles on the dorsal surface, which suggests the possibility that the Adelaide specimen represents a distinct species. It is greatly to be regretted that all our dredging in June, 1932, in and near Lagrange Bay failed to yield even one specimen of Gonimaretia.

MARETIA OVATA

Spatangus ovatus LESKE, 1778. Add. ad Klein, p. 188.
Maretia ovata HAMANN, 1904. Bronn's Thierreich, **2**, abt. 3, p. 1397.

We did not meet with this well known spatangoid but Mr. Ward has kindly sent me 7 beautiful specimens from Lindeman Island, Great Barrier Reef, where he has taken them on the beach at low water and dredged them in 7 fms. The specimens at hand range from 33 x 28 x 9 mm. to 47 x 40 x 15.

BREYNIA AUSTRALASIAE

Spatangus australasiae LEACH, 1815. Zool. Misc., 2, p. 68.
Breynia australasiae GRAY, 1855. Cat. Rec. Ech. Brit. Mus., p. 46.

This common spatangoid, so characteristic of the warmer coasts of Australia, was found abundantly at Lord Howe Island, at Darwin and at Broome, but we did not find it in the vicinity of Perth or south of there, nor has it been represented in the extensive collections made by Professor E. W. Bennett in those regions. Yet it is certainly known from Shark Bay and the Abrolhos Islands and a specimen in the Perth Museum is said to be from Fremantle Beach. At Lord Howe Island it is very common in the lagoon and hundreds are washed up and bleached on the beach. Living specimens, of a distinctly brown color, are common in some places near low water mark and are easily detected, though completely buried in the sand, by the slight convexity of the area over them. Nearly all the specimens seen at Lord Howe were large, ranging from 80 to 100 mm. in length, but a few small ones were seen, the smallest, 28 mm. long. There is some diversity of form in the big tests but it is not great; the largest is 116 x 99 x 56 mm., the width being .86 of length and the height, .48 mm.; a very fine bare test is 113 x 93 x 50.5 mm., the width being .82 of length and the height only .44.

In the vicinity of Darwin, bare tests 45–50 mm. long are abundant on many beaches but no large specimens were seen, nor any living ones, save 2 which were dredged in 5 fms. near South Shell Island on muddy bottoms. Many small dead tests with spines still attached, more or less numerously, were found on East Point Beach, July 13, 1929. These were, and still are, gray with a purple tinge but the larger specimens dredged at Shell Islands were gray with a red tint, though the subanal fasciole was deep purplish.

At Broome, Breynia is excessively common, especially on some parts of the bottom between Roebuck and Lagrange Bays, where they were frequently a nuisance in dredging; in one haul of our small dredge (with mouth 25 inches x 10), we took 525 Breynias, nearly all adults. But it was very noticeable that the Breynias at Broome looked quite different from those at Lord Howe, for they were all a light silvery gray, not brown, and they were much smaller, the largest noted being only about 75 x 65 x 35 mm.

Numerous young specimens were secured; the smallest is quite perfect, measures only 3.75 x 2.75 x 2 mm., and is pure white in color. Up to a length of 30–35 mm. the test remains thin and fragile, but then it thickens rapidly and all our specimens over 40 mm. have a notably stout test; this is particularly marked in the specimens from Darwin. In a young specimen, 35 mm. long, from Lindeman Island, the pinkish-red color of the spines is very marked; it is much the brightest colored Breynia in the present collection; a smaller specimen in the same lot has only a few of the spines red. There can be no doubt that this species affords an opportunity for some very interesting investigations on growth changes in form and in color, on relation of color to environment and on varietal or subspecific differentiation in relation to locality.

The 65 specimens of Breynia at hand are from the following places:

Lord Howe Island: Lagoon beaches, April, 1932. 5 large specimens, 4 bare.

Queensland: Great Barrier Reef, Lindeman Island. Melbourne Ward leg. et. don. 2 specimens, young.

Northern Territory: Darwin, East Point, July, 1929. 3 specimens, young.

Darwin, Casuarina Beach, south end, June, 1929. 5 small specimens, bare tests.

Western Australia: Augustus Island, October, 1933. Beresford E. Bardwell leg. 5 specimens.

Broome, August and September, 1929. 20 specimens, adult and young.

Broome, off Cape Vilaret, 7 fms., September, 1929. 2 fine specimens, adult.

Broome, between Roebuck Bay and Wallal, 1930. R. A. Bourne leg. 2 specimens. Very young. Loan from Australian Museum.

Broome, June, 1932, dredged in 5–7 fms. 21 specimens, adult and young.

LOVENIA ELONGATA

Spatangus elongatus GRAY, 1845. Eyre, J. Exped. Australia, **1**, p. 436.
Lovenia elongata GRAY, 1851a. Ann. Mag. Nat. Hist. (2) **7**, p. 131.

The only Lovenia which we met with in our collecting was taken on the jetty flat, south of Broome, at extreme low water, September 5, 1929. It was noted at a considerable distance as it made every effort to keep pace with the rapidly receding tide. The long spines of the oral surface raised the entire animal very considerably from the sand as it walked upon and by means of them, while the still longer spines of the dorsal surface stood out even more strikingly as if in defence against any attack.

The rate of progress was not only perceptible but was very fast for an echinoid, though unfortunately no exact data were secured. This specimen is now light brown in color, the long spines unbanded; those of the upper surface have a reddish tinge while on the oral surface, if any color is indicated it is lavender. The measurements of this individual are 85 x 63 x 31 mm.

Besides this notable specimen, there are 3 small individuals at hand from Lindeman Island, Great Barrier Reef, sent me by Mr. Melbourne Ward, who found them on the beach at low water. They are 35–45 mm. long and show the purple and yellow coloration often seen in the species. The finest specimen has the oral surface dull grayish, with a greenish tint but most of the dorsal spines are purple or bright red violet, some of the very long ones showing faint traces of banding with greenish-yellow; the long spines on each side of ambulacrum III are greenish-yellow very faintly banded with light dull red.

ECHINOCARDIUM CORDATUM

Echinus cordatus PENNANT, 1777. Brit. Zool., **4**, p. 69.
Echinocardium cordatus GRAY, 1848. Brit. Rad., p. 6.

This almost cosmopolitan sea-urchin appears to be absent from the coast of northern Australia but it is very abundant in the vicinity of Fremantle on the western coast, and it has long been known from the southern coast. The material at hand ranges in size from 15 x 13 x 8 mm. to 46 x 44 x 30 but it throws no new light upon the characters or diversity of the species. The 45 specimens are from the following sources:

Western Australia: Exact locality unknown. E. W. Bennett don. 9 specimens, adult and young, 2 bare.
Between Fremantle and Garden Island, 7–8 fms., October, 1929. 31 specimens, small adults and young.
Same locality but taken in July, 1932. 3 specimens, small adults and young.
South Australia: Port Willunga. W. J. Kimber leg. et don. 2 bare tests.

HOLOTHURIOIDEA

The collection of holothurians contains 1538 specimens representing 28 genera, 83 species, and 5 varieties. Of the genera 5 are new, so far as the name is concerned, but one is merely the genus Ocnus, as used by Semper, revived under a new name (Ocnus being a synonym of Cucumaria), two are separated off from the old, heterogeneous genus Thyone and one from the even less homogeneous Phyllophorus. Of the 83 species, 27 are new, as are all of the 5 varieties. Apparently these varieties are simply color forms and ordinarily will not be recognizable in alcoholic material. But it seems advisable to give them names which will enable zoologists visiting new collecting grounds, or students working on living material, to refer to them.

The new genera are as follows:

Leptopentacta, type, *L. grisea* sp. nov. = Ocnus Semper, *non* Forbes.

Pentathyone, type, *Thyone mirabilis* Ludwig. Monotypic.

Orbithyone, type, *O. megapodia* sp. nov. Monotypic.

Staurothyone, type *S. distincta* sp. nov. Three other species have been named which belong here but their distinctness from each other is open to question; hence the genus contains 2, 3, or possibly 4 species.

Lipotrapeza, type *Phyllophorus vestiens* Joshua. Two species.

The 27 new species are as follows:

Leptopentacta grisea	W. A., Broome.
Thyone alba	W. A., Broome.
axiologa	W. A., Broome.
grisea	W. A., False Cape Bossert
micra	W. A., Broome
minuta	W. A., Broome.
perissa	W. A., Cape Villaret.
Orbithyone megapodia	W. A., Broome.
Staurothyone distincta	W. A., Broome.
Actinocucumis longipedes	W. A., Broome.
Phyllophorus parvipedes	W. A., Broome.
thyonoides	W. A., Cottesloe Beach.
Psolidium granuliferum	W. A., Bunbury.
nigrescens	N. S. W., Port Hacking.
Psolus minutus	Lord Howe Island.
spinuliferus	W. A., off 80-mile Beach.

Stichopus ellipes	W. A., Broome.
Holothuria conica	N. T., Quail Island.
homoea	Lord Howe Island.
macroperona	W. A., Rottnest Island.
Molpadia altimensis	N. T., Darwin.
Aphelodactyla delicata	W. A., off Cape Jaubert.
leucoprocta	W. A., Broome.
Chondrocloea macra	N. T., Allaru Island.
Leptosynapta dyscrita	W. A., Broome.
Protankyra bisperforata	W. A., Broome.
Chiridota magna	N. S. W., Port Jackson.

The 5 new varieties are as follows:

Pentacta caerulea var. *rubra*	W. A., Broome.
Thyone buccalis var. *pallida*	W. A., Broome.
Holothuria impatiens var. *bicolor*	W. A., False Cape Bossut.
Holothuria monocaria var. *viridis*	N. T., Allaru Island.
Stichopus variegatus var. *pallidus*	W. A., off Cape Jaubert.

It should be noted here that in the reviewing and reviving of Selenka's genus Urodemas, which was found necessary in connection with the Australian species *perspicillum*, a new species from Hong Kong has been described herein (p. 500) under the name *Urodemas crassum*. A new species of Pentacta from Japan is also described (p. 446).

Holothurians are common on all parts of the Australian coast where the sea-water is clean and fully salt (i.e. not brackish at all) and there are rock fragments under which they can find shelter or corals or sponges amongst which they can hide. But the number of species and of individuals is undoubtedly greatest in connection with either the Barrier Reef or with the shores and shoals in the vicinity of Broome. Of the 83 species in the present collection about 30 are already known from the Barrier Reef region, while 47 are found on the north-western Coast, southwest of Cape Leveque, in what we may call the Broome region. The coast of Western Australia, south of Northwest Cape, has a good supply of holothurians, more than 20 species being known from there, tho only 14 of them are in the present collection. Naturally we brought back very few holothurians from the southern coast of the continent as we did but two days collecting in those waters, but apparently the number of species is considerable as Joshua (1914 and with Creed, 1915) has recorded more than 25. On the coast of New South Wales, including Lord Howe Island, there are at least 25 species to be found and intensive collecting at favorable points will undoubtedly increase this number.

The literature dealing with Australian holothurians is not very extensive but that which treats of the East Indian region is voluminous and must needs be given careful attention. Of course Théel's great monograph on the "Challenger" holothurians is absolutely indispensable; I cannot refrain from expressing my great admiration for the high quality of that masterpiece. Ekman's paper (1918) on the holothurians from northwestern Australia collected by Dr. Mjöberg has been of constant value in my work, and Engel's (1933) revision of the genus *Pseudocucumis* has also been helpful. Erwe's (1913) report on the holothurians collected by Michaelsen and Hartmeyer in Western Australia in 1905 is a model of what such a report may be. His carefully drawn and well reproduced figures of the calcareous particles of all but two of the species discussed have been of the greatest usefulness in the preparation of the present report. Many published figures of the spicules of East Indian holothurians have been so badly drawn and so crudely reproduced, they are exasperatingly unsatisfactory.

In the study of the present collections I have enjoyed the very great advantage of having Dr. Elizabeth Deichmann at hand for consultation and discussion. Her knowledge of holothurians and her independence of judgment have been equally valuable and if errors herein prove to be surprisingly few she will deserve much of the credit. I take pleasure in thanking her most sincerely for the time she has cheerfully given, and the trouble she has taken, to examine specimens, to make drawings and to discuss debatable points with me.

In preserving holothurians, they were placed in sea-water saturated with Epsom salts ($MgSO_4$), as soon after being taken from the sea as was possible. Most species, placed in such a solution, relax more or less completely after an hour or two (less in the case of small individuals) but many Dendrochirotes never put out their tentacles again if they are fully retracted; there is, however, more or less individual diversity in this particular. After relaxation the specimens were placed in strong alcohol, the amount of water they contain diluting it sufficiently, but very small specimens and slender, thin-walled forms like the Synaptidae, will become stiff and unnaturally shrunken if the alcohol is too strong. After several hours, the specimens were taken from the first alcohol and placed in 70% alcohol; very large specimens should be transferred to fresh 70% alcohol again in a week or two, and if the amount of available alcohol permits, all material should be packed in perfectly clean, fresh alcohol. Decalcification of specimens is most annoying, but it will rarely occur if these precautions are taken. Most species of

Pentacta and some species of other genera having an excessive amount of calcareous matter in the body wall can be preserved as dry specimens by removing from the alcohol and drying as rapidly as possible. It is desirable, however, to add some corrosive sublimate to the alcohol in which they are soaked before drying, as they thus become proof against cockroaches, ants, and similar pests.

CUCUMARIIDAE

Cucumaria mutans

Joshua, 1914. Proc. Roy. Soc. Vict., **27**, p. 4.

This species, hitherto known only from Victoria and South Australia, is shown by the present material to range west and north to Bunkers Bay and Cottesloe Beach, W. A. Joshua and Creed (1915, Trans. Roy. Soc. S. Aust., **39**, p. 18) have called attention to the interesting fact that young individuals are very dark colored but as they increase in size they lose their pigmentation and when mature are nearly white. This is in a general way confirmed by the small series before me, tho the smallest specimen, about 25 mm. long is not quite so dark as four which are about 40 mm. in length; one of these is a very dark brown-purple but the largest is appreciably lighter. These specimens are less than 10 mm. in diameter but a specimen, not 35 mm. long and more than 15 mm. in diameter, obviously the most mature of all the specimens at hand, is a very pale brown or dirty white; this specimen is completely decalcified but I do not doubt the identification. The material at hand, 7 specimens, is from the following localities:

Victoria: South Brighton, 1 adult, decalcified. Loan from Melbourne Museum.

Western Australia: Bunkers Bay, 5 small adults and young. Professor E. W. Bennett, who kindly gave me this material, says of it in his notes: "Colour deep purple. Common. Under large stones on well-sheltered patch of sand on landward side of masses of rock buried more or less completely in the sand; also in sand and grit in rock pools." "The water was rather stagnant, tho by no means landlocked; there were large masses of Cymodocea leaves cast up on the sand and quantities rolling backwards and forwards in the ripple, in a semi-decomposed state. The water was distinctly warm, due not only to the shallowness and stagnation but also probably in part to decomposition."

Western Australia: Cottesloe Beach, 1926. 1 small adult. Washed up on beach and in poor condition but identity indubitable.

Cucumaria semperi

Bell, 1884. "Alert" Ech., p. 147.

This species, originally described from Port Denison, Queensland and Torres Strait, proves to be rather common at Broome. I have no Queensland material for comparison but the spicules are very characteristic and the specimens in hand answer well to Bell's rather meager description. The largest specimens taken at Broome are 45–50 mm. long, and 10–12 mm. in diameter; in some individuals the body curves upward at each end quite conspicuously but this is by no means the rule. There is some diversity of color in life, much less so in the preserved material; small specimens, 25 mm. or less in length, are white or whitish with pedicels and tentacles purplish or else light brown; the contrast between these two groups of specimens is obvious in preserved material. Fully grown individuals may have the bare interambulacra dull flesh red or reddish-white, with the long pedicels purplish-black or dusky. Nearly all of the 37 specimens at hand were dredged on muddy sand in about 7 fms. of water in or near Roebuck Bay, but a few specimens were found in shallow water, and one of the largest was taken at Entrance Point, Broome, from under a rock in a tide-pool well above low water mark.

Pentacta australis

Colochirus australis Ludwig, 1874. Arb. Zool.-Zoot. Inst. Würzburg, **2**, p. 88.
Pentacta australis H. L. Clark, 1932, Rep. Gr. Barrier Reef Exp., **4**, p. 229.

It is too bad that Ludwig (1888, p. 1229) should have decided so positively that his Australian species was synonymous with *Pentacta doliolum* (Pallas) from the Cape of Good-Hope, described more than a century earlier, for all subsequent writers have treated the two as identical. Whether Ludwig's decision was due to inadequate material or to failure to compare the two species side by side, cannot now be known, but even a superficial comparison of material from Australia with specimens from the Cape of Good Hope shows that the two, while congeneric, are really quite distinct from each other. The Australian species is a more angular holothurian with much firmer body wall, a rougher surface with more evident "scales," and smaller, more irregular pedicels. There is no apparent reason for doubting that Deichmann (1930, p. 180) is correct in considering that Pallas'

South African species, and the genotype, is really the holothurian which Théel (1886, p. 64) described from Simons Bay, South Africa as *Cucumaria discolor*. Théel himself thought it might very well be a Colochirus (=Pentacta) and the figures which he gives (1886, pl. IV, fig. 8) of the calcareous particles are good evidence that such is the case. That Ludwig's two small specimens from Angra Pequena Bay are identical with Théels type of *discolor* would seem to be almost beyond question.

That *australis* is a very common holothurian on the Australian coast is demonstrated by the large number of records (of *australis* prior to 1888 and of *doliolum* since that year) from Australia; it has apparently been taken on all sections of the continental coast, even including "the Bight." Moreover it is reported from many East Indian stations and is said to be "one of the most widely distributed species of Dendrochirotae in Japan" (Mitsukuri, 1912, p. 220). Unfortunately, owing to the unsatisfactory state of our knowledge of the genus Pentacta, there is little doubt that more than one species is included in the series of records of the occurrence of *doliolum* and it is simply impossible to determine which really refer to that species.

As far as the *Pentacta doliolum* occurring on the Japanese coast is concerned, I am able to assert that it is neither the true *doliolum* nor *australis*. Thanks to the kindness of my good friend Professor Hiroshi Ohshima, and the Zoological Institute of the University of Tokyo, I have at hand four specimens of the Japanese Pentacta and believe they represent a hitherto undescribed species for which I propose the name *nipponensis*. The holotype (M. C. Z. no. 1739) is a specimen 30 mm. long by 8 mm. wide and 6 mm. high, taken off Misaki, in Sagami Bay, Japan, 35°10′ N. lat., 139°41′ E. long., in 25 fms. by Alan Owston, June 8, 1902. There are 3 smaller paratypes from the same lot. The color of all the specimens is very light brown with the interambulacra much darker and forming five longitudinal brown stripes on the back, sides, and ventral surface. I have seen no Australian Pentacta with this coloration but some specimens approach it in the shades of brown. The body wall is firm, and hard with the excessively abundant calcareous deposits, just as in *australis*, but the particles around the pedicels on the back and sides project much more than in the southern species and form little thorny groups around each pedicel. This alone distinguishes the Japanese Pentactas from any I have seen from elsewhere but would hardly be an adequate reason, by itself, for considering them a distinct species. It is, however, supplemented by a well-marked and apparently constant character in the calcareous deposits of the middle layer. The inner layer of large plates and scales and the outer layer of delicate "baskets" appear to be indistinguishable from those of *australis* but the heavy buttons of the middle layer are distinctive. They arise as simple 4-holed buttons, which develop a large knob on the middle beam and smaller knobs on the margin, commonly 8. They ultimately become very thick and solid buttons with big knobs on both surfaces, but they do not become irregular, more or less spherical, bodies or heavy fenestrated ellipses such as occur in *australis*. This is apparently a reliable specific character for *nipponensis* even if the more obvious external roughness proves inconstant.

No specimens of *australis* were found by us at Lord Howe Island or at Darwin nor was it taken in 1913 at the Murray Islands. The Great Barrier Reef Expedition failed to find it at the Low Isles but there are specimens at hand from the Queensland coast, as well as from Tasmania, South Australia and Western Australia.

On the northwestern coast from Cape Leveque to False Cape Bossut, *australis* is one of the commonest holothurians under rocks along shore. It is also frequently dredged in shallow water. The diversity in size and color is so great that in the field I supposed I was collecting several distinct species but critical study shows they are all diverse individuals of one species. The smallest taken at Broome is 11 mm. long by less than 3 mm. in width and is pure white in color, no pigment having been developed as yet. At the other extreme is an individual 83 mm. long by 20 mm. in width, dark gray in color, ranging from almost black at the anterior end to a very light gray on the middle of the ventral surface, particularly on the ambulacra. Typical adults are 50–65 mm. long, 15–18 mm. wide and 10–12 mm. high. The color is usually gray of some shade, commonly darkest anteriorly and lightest ventrally but some individuals are distinctly brown, either yellowish or less commonly, reddish. Individuals under 30 mm. long are often very light but not always, by any means; some specimens only 15 mm. long are fully pigmented, at least on the dorsal surface. A series of very young individuals taken at Rockhampton, W. A., range in size from 6 x 2 mm. to 9 x 3.5 mm. In color they are light brown above and white below. The calcification of the body wall is not yet sufficient to make them rigidly quadrangular, so that at first sight they hardly suggest *australis*.

In the number, form, degree of development and amount of contraction of the ambulacral appendages, there is also very great diversity which leads to marked differences in the general appearance of the specimens, and this does not seem to be a matter of age. In very small specimens, preserved material shows in some cases a few relatively large pedicels in each ambulacrum but in others, the pedicels can scarcely be made out. In half-grown specimens the difference between bivium and trivium is commonly quite evident, the flattened ventral surface with its narrow, regular series of uniform pedicels contrasting with the rather irregular series of more or less peculiar pedicels on the dorso-lateral angles. The peculiarities of these pedicels seem to be due in large part to the amount of calcification in them.

In life, *australis* is one of the most inert of holothurians. It clings closely to the under surface of rock fragments and its obviously protective coloration enables it to escape observation, no doubt, even that of the searching marine zoologist! Young ones are occasionally found inside of dead shells and in similar protected crannies, or among sea-weeds, corals and similar growths on wharf piles and jetty timbers.

The material at hand is made up of the following lots, containing 108 specimens.

Western Australia: Cape Leveque, Aug. 22, 1929. 1 small light-coloured adult, with tentacles expanded; the stalks are deep purple, the branches cream-white in sharp contrast; the two ventral tentacles are very much smaller than the others.

Broome, Aug. and Sept., 1929. 47 specimens, of all sizes, largely collected along shore but a few were dredged.

Broome, June, 1932. 11 specimens. Adult and young, mostly dredged and generally small.

False Cape Bossut, and south to Eighty Mile Beach, Sept., 1929. 15 specimens, all sizes.

Rockingham "jetty piles among coral, 9/2/32." E. W. Bennett leg. et don. 29 very young specimens.

Bunbury, Oct. 26, 1929. Dredged in Koombana Bay, 5–8 fms. 1 very young specimen.

South Australia: 2 specimens, half grown. Verco collection. Identified by Joshua and Creed. One specimen is remarkably smooth, the large scales being almost completely concealed. Loan from South Australian Museum.

Tasmania: D'Entrecasteaux Channel, Huon Island. T. T. Flynn leg. et don. 1 very young specimen. Bright brown with large yellow brown pedicels. No other specimen of this color or with such large pedicels has been seen, but there is no evident reason for doubting the identification.

Queensland: Port Curtis, off Gatecomb Head. M. Ward leg. 1 small adult specimen. Loan from Australian Museum.
Bowen. 2 very small dark-colored specimens. Labeled "*Semperia typica* Ludwig." Loan from Victoria National Museum.

PENTACTA COERULEA

Plate 16, fig. 4

Colochirus coeruleus SEMPER, 1868. Holoth., p. 59.
Pentacta coerulea H. L. CLARK, 1932. Rep. Gr. Barrier Reef Exp. 4, p. 227.

This is another of the very common holothurians of Australia, particularly abundant in the vicinity of Broome in water 5–8 fms. deep. They may be found occasionally near normal low tide mark but not often under rocks along shore. They occur, especially when young, on gorgonian corals, to the swaying branches of which they cling tenaciously. Most of the specimens taken are 50–75 mm. long, but in deeper water under favorable conditions they reach a much larger size. The largest specimen in the present series was dredged off Long Island, in the Abrolhos group, by the Percy Sladen expedition, and belongs to the Western Australian Museum; it is 105 mm. long, 25 mm. wide and 20 mm. high; of course, the long conical projections of the ambulacra, which are 8–12 mm. long and 3–4 mm. in diameter at base, are not included in these measurements. The smallest specimen at hand is 14 x 3.5 x 3 mm.

The diversity in color is very great for while a large number are gray of some shade, ranging from light pearl to an almost black, or less commonly brown, bright colors, particularly red and yellow, are frequent. It is not unusual for individuals which are dull colored on back and sides, to have bright colors ventrally. The tentacles are usually brown, variegated lighter and darker, but they are occasionally bright red as the ventral pedicels often are. Alcoholic material rarely shows color of any marked tint but specimens killed in formalin, saturated with corrosive sublimate, and then dried, retain both form and color quite well, at least for many months. Semper's (1868, pl. XI, fig. 1) colored figure is very satisfactory for showing the form and general appearance, when fully expanded, of a rather typical individual. Why the specific name *coeruleus* was selected, in view of the fact that blue is one of the few shades which this Pentacta rarely if ever shows, is somewhat puzzling, since Semper almost always suggested specific names which are, at least to some extent, distinctive. Possibly he was using the word in the more primitive sense of "dark-colored," but it seems nevertheless an inappropriate name.

Diversity in the number, size and arrangement of the tubercles, papillae or conical warts of the ambulacra, particularly the dorsal and lateral, is as great as that shown in coloration. Curiously enough the length of these organs is not correlated at all with the size of the animal. Thus in a specimen only 29 mm. long some of the dorsal appendages are a full 5 mm., while another specimen in the same lot 37 mm. long has no appendage more than 2 mm. high. In another individual 45 mm. long, several of the dorsal appendages are 10 mm. or more in length. Specimens from Garden Island (near Perth) and Bald Island (near Albany) have these appendages, as a rule, short and stout, quite different from the Broome material, and I at first regarded them as a separate species, but careful comparison of all the material available to me does not justify giving them even a varietal name. Nevertheless I should not be surprised if better preserved specimens, with more complete data as to color, habitat, etc., justified recognizing this coarse southern form at least as a variety.

The material at hand consists of 63 specimens from the following localities:

Queensland: Port Curtis. M. Ward leg. 1 small specimen.

Western Australia: Augustus Island. B. E. Bardwell leg. 2 typical adults.
Broome, August and September, 1929. 19 fine specimens, adult and young.
Broome, June, 1932. 10 adult and young, dried.
Broome, June, 1932. 3 very young specimens.
Broome, Pearl Shoal, 5–7 fms., June, 1932. 2 good adults.
Off Cape Vilaret, 7 fms., September, 1929. 1 fine adult.
Off False Cape Bossut and southward to Eighty Mile Beach, September, 1929. 12 fine adults.
Carnarvon. 1 poor, decalcified specimen. Loan from Western Australian Museum.
Abrolhos Islands, off Long Island. 2 very large and fine specimens.
Fremantle, near Garden Island. 6 specimens adult and young. Loan from Western Australian Museum.
Albany, off Bald Island. 4 specimens. Loan from Western Australian Museum.

PENTACTA COERULEA var. RUBRA var. nov.

Plate **16**, fig. 5

Length 75 mm.; width of ventral surface, 15 mm., height, 10 mm. Body quadrangular in cross section, the ventral surface sharply set off from the lateral and wider than the dorsal. Back and sides well covered by low, rounded tubercles; along each latero-ventral margin are 18–20 of these about 1.5 mm. in diameter and not more than that in height; above this series on each lateral surface are about 10 similar tubercles, some a little longer than the others, and on the mid-dorsal surface are about a dozen similar ones of diverse size and irregular arrangement; along each dorso-lateral angle are 14–16 tubercles of different sizes but most of them are large, including the largest that the animal bears; these big ones may be 4–5 mm. in diameter but none are more than 2 mm. high. At each end of the midventral ambulacrum are two tubercles of the same size as those in the ventro-lateral series. There are no conspicuous papillae about either the anus or the oral end. Tentacles well expanded, rather small, the two ventral conspicuously the smallest.

Calcareous particles like those of *coerulea* but somewhat less heavy. This is best shown in the large "fenestrated ovoids," the openings into which are conspicuously larger, with much more slender rods between them than in typical *coerulea* of the same size. Color in life bright red, almost uniform, but a little lighter at tips of tubercles. Preserved in alcohol, the specimen has become dingy yellow-brown.

This beautiful holothurian (M. C. Z. no. 1581) was picked up far out on the jetty flat at Broome during the extremely low tide of Sept. 5, 1929, but unfortunately only a single individual was found. The temptation to give it full specific rank has been strong but in view of the diversity shown by *coerulea* in both form and color, it seems best to treat it as only a variety of that species. Altho one individual of *coerulea* was seen which was similarly red, no specimen with the form and tuberculation of *rubra* has been noted either living or in the large amount of preserved material studied, so it has seemed desirable to give it a distinctive name.

PENTACTA CRASSA

Plate **16**, fig. 1

Colochirus crassus EKMAN, 1918. K. Svenska Vet.-Akad. Handl., **58**, No. 6, p. 6.

This large and rather dull colored species does not seem to be very common or widely distributed. The type material was taken 45 miles west southwest of

Cape Jaubert in about ten fms. of water. At Broome, *crassa* was common only near the jetty where at very low tides a number of large specimens were taken. In 1932 a few small ones were dredged between Broome and Cape Jaubert but we did not meet with it elsewhere in our extensive dredging up and down the coast. In form and color, *crassa* shows little diversity, the specimens from Broome agreeing well with Ekman's material. In size, however, there is more diversity, the smallest one of the 8 specimens at hand is 35 x 15 x 10 mm. while the largest is 145 x 40 x 30 mm.; it is thus the biggest species of Pentacta on the northwest coast. Ekman's detailed description needs no other additions, so far as my material is concerned. The gray color of the animal harmonizes well with the gray sandy-mud in which it lives more or less buried, but there is often a tint of red even on the back; the extent and intensity of the salmon-red on the ventral surface differs greatly in different specimens; it is wholly lost in alcoholic material.

PENTACTA TUBERCULOSA

Plate **16**, fig. 2

Holothuria tuberculosa QUOY and GAIMARD, 1833. Voy. "Astrolabe," **4**, p. 131.
Pentacta tuberculosa H. L. CLARK, 1921. Ech. Torres Strait, p. 171.

This is one of the common holothurians at Broome and along the northwest coast. It occurs with *crassa* around the timbers of the jetty at Broome and is easily recognized by its bright red and yellow colors and the absence of conspicuous papillae. Papillae, low and broad, are present in numbers on the back and sides, but in contrast to those of *coerulea* and *crassa* they are inconspicuous. Semper's (1868, pl. XII, fig. 1) colored figure of *Colochirus anceps*, which is generally considered a synonym of *tuberculosa*, is not altogether like Australian specimens, as the yellow has too marked a green tinge and the papillae are too slender and acute. But these differences are unimportant and are easily accounted for as due to differences in age and contraction of the specimen. Alcoholic material is yellowish, dirty white or pale gray.

Erwe (1913) records specimens of *tuberculosa* from Port Hedland and Shark Bay but Ekman (1918) did not recognize it in Mjöberg's collections from near Cape Jaubert, while we did not find it *east* of Broome. The material at hand includes 2 very young specimens, 16 x 6 x 5 and 19 x 7 x 6 mm. They are quite quadrangular and flat dorsally but markedly pentagonal at the oral end. The low tubercles and calcareous particles reveal their specific identity. The other specimens are all small adults, the largest specimen being only about 100 mm. long x 35 in diameter.

The 12 specimens at hand were taken as follows:

Western Australia: Broome, mudflat near jetty, August and September, 1929. 6 adults.
Broome, 1930. R. A. Bourne leg. 1 small adult. Loan from Australian Museum.
False Cape Bossut, September, 1929. 2 specimens.
Broome, dredged in 5–8 fms., June, 1932. 1 small adult (dry) and 2 young individuals.

LEPTOPENTACTA[1] gen. nov.

Body elongated, slender, pentagonal, more or less curved, encased in a firm body wall made up of enlarged scales or small plates, covered with a densely calcified epidermis; pedicels relatively few in a single straight or zigzag series on each dorso-lateral angle, and in a more or less crowded double series on each ventral ambulacrum; tentacles 10, small, the ventral pair smaller than the others.

Genotype, *Leptopentacta grisea* sp. nov.

This is the group which Théel (1886) calls Ocnus in the "Challenger" Report, but unfortunately we cannot use that name for it. The type of Ocnus must be either *brunneus* or *lacteus* of Forbes and those British species are probably identical and belong, according to the best authorities, in the genus Cucumaria; hence Ocnus is a synonym of that name. It therefore cannot be used for the group of East Indian forms described by Semper (*imbricatus, pygmaeus*), Sluiter (*javanicus*) and Théel (*typicus*). This seems to be a homogeneous group worthy of a distinctive name, and "Leptopentacta" emphasizes its relationship to, as well as its most obvious difference from, typical Pentacta. Whether *Ocnus molpadioides* Semper belongs here seems to me very doubtful.

LEPTOPENTACTA GRISEA[2]

Length 70 mm.; diameter at middle of body about 5 mm.; anterior end blunt and rounded in its present contracted condition scarcely 4 mm. in diameter; posterior end attenuate, only 2 mm. thick at the anus; body strongly curved, measuring about 63 mm. along the mid-dorsal interambulacrum and over 85 mm. along the mid-ventral ambulacrum. Pedicels about 50 in each dorsal ambulacrum, arranged in a markedly zigzag manner at the middle of the body but in more nearly single series at each end; these pedicels are 1–2 mm. high and distinctly pointed near the middle of the animal but become lower and blunter near each end; in the ventral ambulacra, the pedicels are about twice as numerous and form distinctly double series, except at each tip end; they are lower (in their contracted condition) blunter and larger than the dorsal pedicels. Tentacles 10, rather small, the ventral pair smaller than the rest. Calcareous ring not very stout, the radial pieces rather narrower than the interradial, but like them in having distinct anterior points; there are well marked posterior prolongations on the radial pieces, about equal to the height of the piece itself. Madreporic canal single, small. Polian vessel single, slender but not very long (about 5 mm.).

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[1] λεπτός = *slender* + Pentacta, the genus to which these forms are most nearly related.

[2] *griseus* = gray, in reference to the coloration.

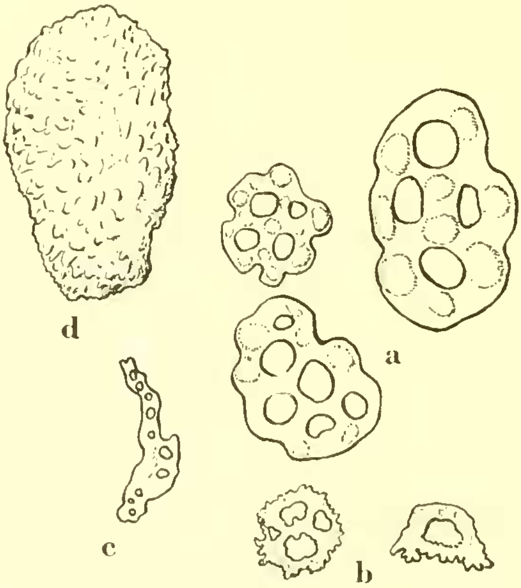

Fig. 37. Leptopentacta grisea. a. Knobbed buttons. b. Baskets. c. Supporting plate from pedicel. d. Large ovoid mass from tip of pedicel. All figures x 425.

Calcareous particles in the body wall of three distinct types. Forming the body-wall itself are large scales or small plates, approximately a millimeter in diameter, but often more and often less; they are of irregular shape but with rounded angles, and form about three irregular longitudinal series in each interambulacrum at the middle of the body; they are closely joined but do not seem to overlap. Covering these plates but not really obscuring them is an epidermis crowded with minute calcareous particles; the inner layer of these is made up of perforated plates, many, if not most, of which are fairly symmetrical knobbed buttons 40–80μ in length and perforated with 4 holes (fig. 37, a); sometimes there are 5, or 6, holes; the thickness of these plates, the number and size of the knobs and the regularity of form and of margin show very great diversity. The outermost layer of particles is made up of delicate small "baskets" similar to those found in various species of Pentacta and Thyone, but very small, only about 30μ in diameter (fig. 37, b). The pedicels are more or less rigid with large, perforated, curved supporting rods (fig. 37, c) and plates and buttons similar to those in the body wall; no end plates are present but the tip of each pedicel has several large, thick, rough, ovoid masses of calcareous matter nearly half a millimeter long (fig. 37, d). The tentacles contain large quantities of supporting rods of diverse sizes and numerous perforated plates; they are, however, easily retractile. There are no calcareous teeth or calcified papillae about the anus.

Color in life uniformly gray above, on the sides and at both ends of the body with the ventral surface white or whitish; the gray is the same color as that of the sandy-mud in which the animal lives. Preserved specimens are also gray but the white ventral surface has become dingy or yellowish.

Holotype, M. C. Z. no. 1588 from the jetty flat at Broome, Western Australia, August, 1929.

This remarkable holothurian, quite different from any other found at Broome, is common in the sandy-mud near the jetty at, and for some distance above, low tide level. Apparently it lives entirely buried, but when undisturbed and covered by water it probably has each end of the strongly curved body at the surface. When the tide is out it seems to contract so that no trace of it is visible, but digging with a spade at random frequently produced one or more specimens. No very small ones were seen, the smallest of the 21 specimens in the collection being about 40 mm. long by 5 in diameter. The largest specimen taken is now 75 x 8 mm. As the body wall is so rigid it is probable that the preserved specimens are nearly life-size. The animal is very inert and neither in the sieve nor when handled were any movements detected. This species is distinguished from the previously described Cucumarias of the same type by the calcareous particles and the size and arrangement of the plates in the body-wall. It does not seem very similar to any one of them.

Pseudocolochirus axiologus

Colochirus axiologus H. L. Clark, 1914. Rec. W. A. Mus., **1**, p. 171.

This remarkable holothurian was described from two specimens taken at Port Hedland, northwestern Australia. It was therefore a great pleasure to take three specimens in or near Pender Bay, northeast of Broome, in June, 1932, in 5–8 fms. of water. Three additional specimens, taken still further east at Augustus Island, have been sent by Mr. Bardwell. This additional material is of importance in considering the questions which have arisen regarding the validity of the species.

In life the outstanding feature of the animal is its bright coloration. This was not indicated in the types nor is it retained by preserved material; obviously it is of little value as a character by which to identify alcoholic specimens. The colors are so similar to those of *Cucumaria tricolor* Sluiter that I supposed my specimens were surely that species. My field notes say: "Like Sluiter's figure. A large bright colored species, yellow, blue (on interambulacra) and red (ambulacra and anal region); oral and cloacal margins, deep brown. Tentacles white, brown and orange." The difference in the color of the tentacles is probably not significant but conspicuous morphological differences forbid treating the two species as identical. Sluiter's figure and description demonstrate the existence of obvious ambulacra with numerous pedicels on the dorsal surface. These are almost entirely lacking in all specimens of *axiologus*, except for the band of red color in life. In the specimens from Augustus Island a few scattered, minute, completely contracted pedicels can be made out with a lens in the dorsal ambulacra but a superficial examination leads one to think them lacking. Another reason for considering *axiologus* distinct from *tricolor* is the absence of calcareous deposits in the body wall. I find nothing of this nature in my Australian specimens, while Sluiter describes and figures characteristic perforated plates in *tricolor*. In this connection attention should be called to Ekman's (1918, p. 26) account of two small holothurians (41–49 mm. long) from northwestern Australia which he considers the young of *axiologus*. If he is correct, and I am far from denying that he is, the Australian species has plenty of calcareous material in the body wall before it is half grown and then loses it entirely with maturity. But the spicules which he figures are totally different from those of *tricolor*. It has been suggested that Pseudocolochirus is monotypic and that both *tricolor* and *axiologus* are synonyms of the genotype, *violaceus* Théel, but the same objections hold to identifying the Australian material with the "Challenger" species that prevent calling it by Sluiter's name. Whether the "Challenger" and "Siboga" species are identical, I have no means of deciding but from the figures given, it seems to me unlikely. I am therefore referring three species to Pearson's (1910, p. 172) useful genus.[1]

Of the six specimens of *axiologus* at hand, the three from Augustus Island are smaller and lighter colored. They range from 85 to 95 mm. in length and are for the most part yellowish buff in color. They show to an unequal degree traces of the red which marked the ambulacra in life. The form of the body is that typical of the species — a nearly flat back and a highly convex ventral surface. The anal teeth are conspicuous but there seem to be no calcareous particles in the body wall. The tentacles are completely retracted. The three specimens from Pender Bay are considerably larger and are duller colored; in spite of their bright red, yellow and blue of life, they are now simply dull purplish-gray with traces of violet here and there. In two specimens the tentacles are expanded and show the lesser branches as dark brown, the stalk and its main subdivisions light gray. My original description of *axiologus* was erroneous in saying that the two ventral tentacles are ''much smaller'' than the other eight. The ten tentacles are all of approximately equal size. My error was due to the strongly contracted condition of the tentacles in the type material.

The largest of the Pender Bay specimens is remarkable not only for its size but for the hexamerous condition of the posterior half of the body. In life, this individual had a longitudinal diameter of 120 mm. and a transverse diameter of about 75; measured along the somewhat concave back from just behind the tentacles to the anus, the length was 125 mm. but measured from the base of the two ventral tentacles along the midventral ambulacrum to the anus it was 325 mm.; the oral disk was 40 mm. across. In the alcoholic specimen these dimensions have undergone great and very unequal shrinkage; the length along the back is now 75 mm. but along the ventral ambulacrum only 150; the longitudinal diameter is about 100 mm., the transverse about 65 and the diameter of the oral disk about 35. Near the middle of the body, in this specimen, the midventral ambulacrum divides abruptly into two equal branches which diverge considerably at first and then run, well-spaced from each other, convergingly to the anus, where there are six equal, and as usual conspicuous, anal teeth. This is the most perfect case of posterior hexamerous symmetry I have ever seen in a holothurian.

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[1] For some unknown reason this paper of Pearson's was never listed in the Zoological Record and the generic name Pseudocolochirus never appeared in the Record's index to generic names until the volume for 1930. Presumably because of this Deichmann in her monograph on the holothurians of the western Atlantic (1930) publishes Pseudocolochirus (p. 181) as a *genus novis* and says that the name was proposed by Pearson in a letter to Mortensen "but was never published." She designates the same type as Pearson (namely *Colochirus violaceus* Théel) but oddly enough the Zoological Record for 1930 gives the type as *mysticus* sp. nov.!

PENTATHYONE[1] gen. nov.

Dendrochirote holothurians with 10 tentacles of which the two ventral are distinctly smaller; calcareous ring stout, not composed of many small pieces but with conspicuous posterior radial prolongations; in normal condition, body more or less quadrangular; the ventral side composed of three ambulacra with the intervening two narrow, interambulacra; the lateral areas and the back, each made up of one broad interambulacrum, the two remaining ambulacra occupying the dorso-lateral angles; body wall rather thick, especially on the dorso-lateral angles; pedicels small and numerous, in adults completely covering the ventral surface, so that the individual ambulacra are not distinguishable; at both ends of the body the ambulacra are more or less conspicuous from the presence of large tubercles arranged in a crowded double series, each tubercle terminating in a single rather large pedicel; in the contracted holothurian, these radial series of tubercles meet over the mouth and over the anus as they do in Pentacta, tho they do not form "valves;" they are much less noticeable in the expanded animal; along the dorso-lateral ambulacra the tubercles, which show very great diversity in number and conspicuousness, form a fairly continuous series, but on the ventrolateral areas, they are lacking at and just anterior to the middle; in large individuals there are generally quite a number posteriorly; besides the tubercles, there are pedicels present on all the ambulacra and usually to a greater or less extent on the interambulacra, also, though they may be quite wanting on the back and even on the lateral areas near middle of body. Calcareous particles in body-wall more or less scattered (except near the papillae) very small tables consisting of a disk with four large perforations and generally one or more (often four) much smaller ones and a spire of two vertical rods connected by one crossbar near the tip; there is much diversity in length and stoutness of these rods and the number, form and size of the points in which they terminate; in spite of the diversity shown in both disk and spire these tables (figured by Ludwig, 1875, pl. VI, fig. 18) are very characteristic. They are obviously similar to those of *Thyone fusus* and *papuensis* but are much smaller and more irregular.

Genotype, *Thyone mirabilis* Ludwig, 1875.

Only a few years ago (1932, Great Barrier Reef Exp. 1928–29, **4**, pp. 221, 222) I carelessly confused *mirabilis* with *Thyone papuensis* (Théel), owing to completely inadequate material. Lampert (1889) in discussing a single specimen of *mirabilis* from northwestern Australia, pointed out the resemblance that it showed to Pentacta, and the impropriety of placing it in Thyone, but he did not venture to give it a new generic name. Now, in the light of ample material, I am not willing to let so distinctive a form remain in Thyone, which is too heterogeneous as it is. Pentathyone bears very much the same resemblance superficially to Thyone that Stichopus does to Holothuria, and I am inclined to regard this distinctive body form as the chief character of the genus. In this it approaches Pentacta but the soft body wall with little calcareous material in it distinguishes the genus readily. The calcareous particles are also a distinctive feature, tho recalling those of *Thyone fusus*. No holothurian, with fundamentally different particles, should be placed in Pentathyone. A brief diagnosis of the genus might be expressed as follows:

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[1] *Pentacta* + *Thyone*, in reference to the combination of features occurring in each genus.

Dendrochirote holothurians with 10 tentacles; conspicuous but not polyplacous, posterior prolongations on radial pieces of calcareous ring; quadrangular body with crowded pedicels ventrally; double series of tubercles, with pedicels, on ambulacra dorsally; calcareous particles in body wall, small tables with spire of only two rods and disk with few perforations.

PENTATHYONE MIRABILIS

Plate 16, fig. 3

Thyone mirabilis LUDWIG, 1874. Arb. Zool.-Zoot. Inst. Würzburg, **2**, p. 93.

Although the type locality for this holothurian is on the Queensland coast, it occurs at Darwin and is quite common at Broome. I was at first inclined to consider the specimens from Broome as a closely related but distinct species but direct comparison with some excellent specimens from Port Curtis, Queensland, has convinced me that Erwe (1913, p. 362) is probably right in considering his specimens from the northwest coast as identical with Ludwig's. Several of those from Broome are considerably larger than any previously recorded, the largest being 80 by 18 mm. In life, the large specimens were well over 100 mm. in length when normally expanded. The shape of the body, as pointed out by Lampert (1889, p. 835), and the habits are like those of Pentacta and not at all like Thyone or Cucumaria. On the other hand the texture of the body-wall and the character of the calcareous deposits, which are not abundant, separate *mirabilis* sharply from the hard and inert Pentactas.

The color in life shows great diversity without any very evident reason. A specimen dredged near the jetty at Darwin, was, according to my field notes, "2 inches long, delicate creamy white, the dorsal projections long, attenuate of unequal size." When killed, all the projections contracted and "pigment became evident, especially in feet and interambulacra. Preserved specimen thus *very* unlike living one." A specimen dredged near the Shell Islands, Darwin, two weeks later "was nearly uniform brown but on being preserved became so much like" the preceding that it is referred to the same species without doubt. The third Darwin specimen was creamy-white in life and was well concealed in a sponge; it became dark on preservation. At Broome, no very light colored specimens were noted, nor was there any striking difference between adults and young. But there was much diversity of coloring and some of the specimens were quite handsome. The ground color ranged from yellowish-brown with more or less of a greenish cast to a deep purple, almost black in some cases, when strongly contracted. But the introvert was yellowish- or grayish-white, the tentacles white speckled with black, and the pedicels and tips of papillae bright red. The large dorso-lateral papillae are light in comparison with the ground color of the body. Preserved material is equally varied or more so. Some specimens are creamy white, particularly the large papillae, with tentacles and pedicels dark; often the more or less bare interambulacral areas are so dark as to appear like 3–5 dark stripes; this sort of coloring is very marked in the material from Port Curtis and is evident in certain specimens from Broome. On the other hand many of the Broome specimens are quite reddish or reddish-brown and a few are very dark, almost a deep purplish-brown. The diversity in number and distribution of pedicels is nearly as great; in the Port Curtis specimens there are few pedicels on the dorsal and lateral interambulacra and these are at the ends of the body; in most of the Broome material pedicels are more or less generally present on all the interambulacra.

Like several species of Pentacta, *mirabilis* lives in shallow water, among sponges, horny corals, and other animal growths, as well as where there is some coralline algae or other vegetation. We took specimens from tide-pools at False Cape Bossut and at very low tides from far out on the jetty-flat at Broome. We also dredged a number of specimens in water 7 fathoms deep or less.

Ludwig's specimen, which was unique, came from Bowen, Queensland, and Bell (1884) reported a single specimen from Port Denison. Lampert (1889) records a single small specimen from the Dampier Archipelago, northwestern Australia and Erwe (1913) lists eight specimens from Port Hedland and Sharks Bay. Sluiter's (1901) specimens from near Flores in 64 m. are hardly to be referred to *mirabilis;* the colored figure given is quite unlike any living specimen I have seen of that species and the entire absence of calcareous particles prevents any real identification. Koehler's (1895) reference of a specimen from the Sunda Islands is negatived, even as he expected, by the calcareous particles — the tables of *mirabilis*, though showing more or less diversity, are very distinctive. So far as we know then, this interesting holothurian is found only on the tropical coasts of Australia, but ranges from Bowen to Shark Bay.

A careful study of Ekman's (1918) description and figures of his *Cucumaria areolata* satisfies me that that supposedly new species is based on two badly contracted specimens of *P. mirabilis*. They were taken in shallow water, west southwest of Cape Jaubert, W. A., and are in such strongly contracted condition that the natural body form is quite obliterated. The photographs agree well, however, with specimens of *mirabilis* in similar condition. Considering these puzzling specimens to be Cucumarias, it is not strange that Ekman overlooked their resemblance to *mirabilis*. That so excellent a worker should do this is further evidence that a new genus is needed for Ludwig's species.

The material in hand consists of 43 specimens, ranging in size from 15 x 4 to 80 x 18 mm. The smaller individuals of course have fewer pedicels and less conspicuous dorsal papillae, and the reference of such specimens to Cucumaria would not be unnatural. The localities where this material was collected are as follows:

Queensland: Port Curtis, off Gatecombe Head, 9–12 fms. 4 adult specimens in fine condition. Loan from Australian Museum.
Northern Territory: Darwin, July, 1929. 3 small specimens.
Western Australia: Augustus Island, October, 1933. Beresford E. Bardwell leg. 1 small adult.
  Broome. 31 adults and young.
  False Cape Bossut, September, 1929. 2 small adults.
  Between Broome and Wallal, 5–7 fms., September, 1929. 2 adults.

THYONE BUCCALIS

STIMPSON, 1855. Proc. Acad. Nat. Sci. Phila., 7, p. 386.

In spite of the fact that Stimpson does not mention the calcareous deposits in his specimens from Port Jackson, all subsequent writers seem to agree that they are just like those of *Stolus sacellus*, and the name *Thyone sacellus* has been widely used. But if this assumption is correct, the name given by Stimpson must be used and hence *Thyone buccalis* is the correct name for this common and widely distributed species, the calcareous particles of which are so very distinctive.

As the previously known range extends from Japan to Aden in the north and from Port Jackson to Delagoa Bay in the south, it is not strange that this Thyone is common on the northern coast of Australia. We found it at East Point, Darwin, and discovered that at Broome it is one of the most abundant holothurians, occurring in large numbers in the soft mud around more or less buried rocks, well above low water mark, on the jetty flat. It was also frequently dredged. The color in life ranges from bright yellow-brown, red-brown or seal brown to purplish-black; the pedicels and tentacles are usually much darker, often nearly black, but there is some diversity. The colors change little on preservation. The body wall is firm and smooth and when strongly contracted is quite hard. The largest specimen is 110 mm. long by 30 mm. thick, but the usual size of adult specimens is 75–90 mm. in length with a diameter of 18–20 mm. There are many young individuals in the present series, the smallest being 15 mm. long by 5 in thickness.

The material at hand (66 specimens) consists of the following lots:

Queensland: Port Curtis, Rat Island. Ward and Boardman leg. 1 specimen.
Northern Territory: Darwin, East Point, July 13, 1929. 1 fine adult.
Western Australia: Broome, jetty flat; Entrance Point; and dredging at Pearl Shoal just outside Roebuck Bay in 7–8 fms. 56 specimens.
False Cape Bossut, and dredge-hauls between there and Eighty Mile Beach, Sept. 8–10, 1929. 7 specimens.
Exact locality unknown. 1 very large specimen, property of the Perth Museum.

THYONE BUCCALIS var. PALLIDA var. nov.

Length 65 mm., diameter, 15 mm. Similar to *buccalis* in body form, texture of body wall, distribution of pedicels and all internal characters, but differing conspicuously in its pure white color and light brown tentacles; this is not due to bleaching but to a lack of pigment. The calcareous particles are like those of *buccalis* but there seem to be no rosettes in introvert and tentacles, tho there are many slender rods; at base of tentacles these have expanded and perforated ends, and these ends where broken off resemble rosettes: in the tentacle branches and distally the rods are very slender, only a little expanded at tip, and have but one perforation there or none. Most of the buttons in the body wall have fewer and larger knobs on the margin than those of the specimen of *buccalis* with which *pallida* was first compared. But further study of this point and examination of several specimens has convinced me there is no constant difference, the diversity in number and form of the marginal knobs is so great even in a single individual.

Holotype, M. C. Z. no. 1609 from the jetty-flat at Broome, W. A., near low water mark, Sept. 1929.

This specimen was collected with *buccalis* and *grisea* and was supposed to be a peculiar individual of *buccalis*, but it seems best to set it out clearly from the others by giving it a varietal name, tho I am suspicious that the type is only an individual freak.

Thyone papuensis

Thyone fusus var. *papuensis* Théel, 1886. "Challenger" Holoth., p. 92.
Thyone papuensis H. L. Clark, 1921. Ech. Torres Strait, p. 167.
Thyone castanea Lampert, 1889. "Gazelle" Holo., p. 836.

This holothurian occurs at Broome but it is not very common. It usually contracts badly when collected and it seldom relaxes normally in Epsom salts. Hence only one of the specimens at hand is sufficiently extended to give any proper idea of the size or form in life; even in this specimen the introvert is reversed and extruded. This individual is about 75 mm. long by 18–20 in diameter and yellowish-brown in color, the tentacles not very different; the body tapers much posteriorly. The smallest specimen is only about 12 mm. long by 3 or 4 in diameter but is strongly contracted. All the other specimens are almost spherical, firm bodies of a dull brown, with tentacles fully expanded but the introvert fully extended, and in three cases completely severed from the body. These expanded tentacles have the trunk and branches white like the introvert, but the terminal branchlets are very dark brown in marked contrast. The smallest specimen was found on the under side of a rock near low water mark. The others were taken among rocks in the sandy-mud of the jetty-flat or were dredged on a similar bottom in 5–7 fms. of water near Broome. There are 8 specimens altogether. There seems little reason to doubt that Lampert's *T. castanea* is based on small, contracted specimens of *papuensis*.

Thyone vercoi

Joshua and Creed, 1915. Trans. Roy. Soc. S. Austr., **39**, p. 19.

There are two specimens of this South Australian species, loaned by the South Australian Museum. One is only 14 x 7 mm., light gray in color and very much contracted; the other is 50 x 20 mm., light brown in color, well expanded except that the tentacles are within the introvert. Both specimens came from near the semaphore on Le Fevre's peninsula, St. Vincent Gulf.

Thyone alba[1] sp. nov.

Length 21 mm., quite contracted; diameter about 9 mm. at middle of body, which tapers but little towards either end. Body wall moderately thick, but not at all hard. Pedicels long and rather numerous, more so ventrally than dorsally, very irregularly distributed. Tentacles 10, the 2 ventral smaller. Calcareous ring about 1.5 mm. high, with a projection half a millimeter long on the anterior margin of each piece; posterior margins of interradial pieces very straight; radial pieces with very slender paired prolongations, more than 3 mm. long; these projections are apparently made up of several pieces. Polian vessel single and madreporic canal single, confined to dorsal mesentery.

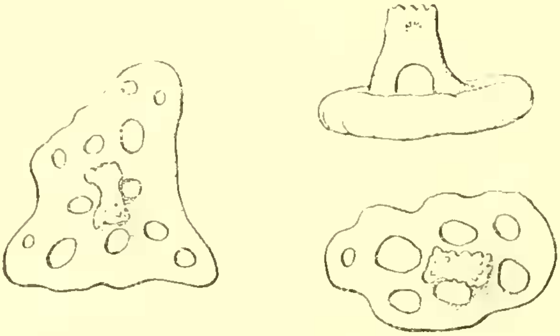

Fig. 38. Thyone alba. Tables. x 425.

Calcareous particles in body wall, tables (fig. 38) of small size, with irregular disks and rather solid spires; as a rule the disk is longer than wide but it may be squarish or almost triangular; it is perforated primarily by about 3 pairs of holes of unequal size, distal to which there are usually from 1 to 6 or more smaller holes, irregularly placed; disks are 70–90μ long, and 40–75μ wide; the spire is rather low and stout, consisting of two vertical rods, more or less closely joined at top and also often by a cross bar which may merge with the top; long axis of top parallel with long axis of disk; supporting tables in the pedicels, with narrow, curved, rod-like disks, abundant. In the introvert and at the base of the tentacles, the tables become coarse and irregular in form, with more perforations in the disk and more and larger points on the spire; they are soon replaced by rosettes, which are elongated and gathered in heaps in the tentacles where they intergrade imperfectly with the few and scattered tentacle-rods, which are small and slender, and perforated or simply forked at the tips. Anal teeth well developed, the whole periproctal area being quite calcareous.

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[1] *albus* = white, in reference to the color in life.

Color, white with pedicels cream-color; posterior end of body becomes grayish distally.

Holotype, M. C. Z. no. 1610, from sandy mud, near normal low-water mark, jetty-flat, Broome, W. A., Aug. 29, 1929.

My field notes say: "Thyone sp.? Pure white, rather Cucumaria-like, long pedicels. 1 specimen found in sieve on mud flat south of jetty." Oft repeated digging never revealed another specimen, nor did we meet with one during the 1932 collecting.

The nearest ally of this species would seem to be *Thyone dura* Koehler and Vaney (1908, p. 40) of which 2 small specimens were taken by the "Investigator" in the Arabian Sea, west of Bombay in 44 fms. But *dura* has a very different body-wall, the body tapers to each end and the calcareous tables are larger, with higher spires and more perforations in the disk. Nevertheless the resemblance in the calcareous ring and in the supporting tables of the pedicels is noteworthy. Sufficient material might demonstrate that *alba* is the adult of *dura*, but this seems to me highly improbable.

THYONE AXIOLOGA[1] sp. nov.

Length rather more than 35 mm. with extended tentacles; body spindle shaped, about 8 mm. in diameter near middle, tapering markedly towards each end. Pedicels long and slender, very numerous ventrally, much less so near middle of dorsal side; no indication of ambulacra evident. Tentacles 10, the 2 ventral markedly smaller. Calcareous ring very high, polyplacous, with very long posterior prolongations on the radial pieces; short projections on the anterior margin of the ring are not conspicuous; total height is fully 10 mm. Polian vessel and madreporic canal not notable.

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[1] ἀξιόλογος = *remarkable*, in reference to its distinctive characters.

Calcareous particles in the body wall, crowded tables (fig. 39) with oblong or squarish disks having few (6–10) small perforations, a rather stout spire, of two rods and a spiny oblong top, and a conspicuous half ring on the lower surface of the disk, opposite the spire; in pedicels, numerous supporting-tables with curved rod-like disks; in introvert, numerous small tables with more or less reduced spire and many (20–30) perforations in the elliptical or circular disk; in tentacles very numerous, elongated rosettes that intergrade with the much rarer, small supporting rods which are forked or perforated at the ends. Anal teeth apparently lacking.

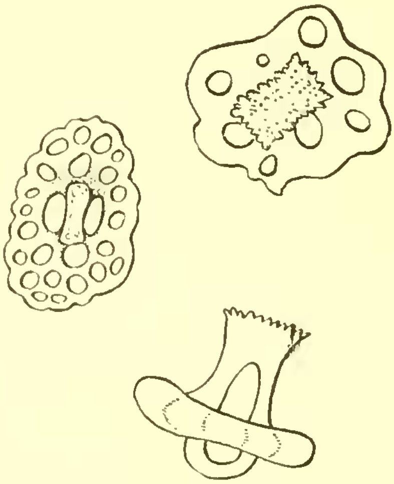

Fig. 39. Thyone axiologa. Tables. x 425.

Color, light gray; tentacles yellowish; introvert whitish; many pedicels are faintly red or rust-color at tip.

Holotype, M. C. Z. no. 1611, from under side of a rock near low water mark, at Entrance Point, Broome, W. A., Aug. 8, 1929.

This seems to be a well marked species and it is to be regretted that no further specimens were found either in 1929 or 1932. In the presence of a half-ring on the lower surface of the tables, *axiologa* reminds one of the Panamic species, *similis* Ludwig (1886, p. 23) and the West Indian species, *pseudofusus* Deichmann (1930, p. 168), but the tables are otherwise quite dissimilar. I know of no other Thyones with tables of this type.

Thyone grisea[1] sp. nov.

Length 50–55 mm., diameter 10–12. Body not very stout, tapering more or less considerably towards each end; body wall quite firm but not hard. Pedicels of moderate size, numerous everywhere, but somewhat less so on the middle of the back. Tentacles 10, the 2 ventral smallest. Calcareous ring rather stout, in the younger individuals distinctly polyplacous but in large adults more solid, the separate plates hard to distinguish; interradial parts 2–4 mm. high, slightly concave posteriorly, with a stout anterior projection; radial parts of equal height, with abruptly tapered posterior prolongations little more than 2 mm. long; in fully mature individuals the prolongations are relatively much shorter than in younger specimens. Madreporic canal and polian vessel, single, as usual.

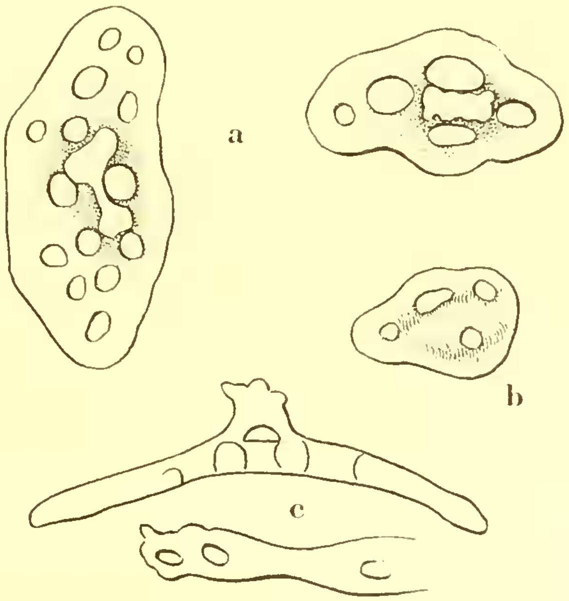

Fig. 40. Thyone grisea. Tables (a), spireless disk (b) and supporting tables of pedicels (c.) x 425.

Calcareous particles in body-wall, very numerous, stout tables (fig. 40, a) with oval or elliptical disks, with 4 or more perforations and a low compressed spire of two pillars, curved towards each other and ordinarily united at the top; there is great diversity in size and form of these tables, the disk ranging from 50 x 35μ to 115 x 50μ; small disks have 4 perforations as a rule but in the larger ones there are 12–15; the outline of the disk, excepting those with 4 perforations,

[1] *griseus* = gray, in obvious reference to the color.

is more or less irregular and asymmetrical; many of the smaller ones have rudimentary spires or none (fig. 40, b); tables with disks over 80μ long and with more than 8 perforations are exceptional. Supporting tables or rods (fig. 40, c) in the pedicels not very numerous; the spire is low and irregular or wanting, while the disk is narrow, elongated and curved as usual, with the ends expanded and perforated; a large end-plate with rather coarse mesh is present in the pedicels. Introvert and stalk of tentacles with numerous big supporting rods and less numerous, minute rosettes; rods, flat, 300–350μ long, usually expanded at middle (50–60 wide) and at ends, with numerous perforations throughout; branches of tentacles with numerous rosettes and less frequent minute supporting rods with which the rosettes intergrade. Anal teeth wanting, but anal papillae are present and there is more or less calcification about them.

Color gray-brown, ranging from quite light to quite dark; some individuals are a dull purplish and some a more red-brown; many specimens are distinctly darker at the ends than at the middle; the pedicels are of essentially the same color as the body-wall, but the tentacles may be somewhat darker.

Holotype, M. C. Z. no. 1612, from False Cape Bossut, W. A., September 8, 1929.

This is a fairly common holothurian alongshore at Broome and southwestward along the coast, but it is not often dredged, and in 1932 we only secured a single specimen. In habitat and habits, *grisea* is much like *buccalis* and the two species are associated on the jetty-flat at Broome, though *buccalis* is more abundant. It is hard to understand why so common a holothurian as *grisea* should not have been described hitherto, but there is apparently no name available, nor any known species with which it can be confused. There are 27 specimens of *grisea* at hand of which 16 are from the vicinity of False Cape Bossut and 11 from Roebuck Bay, chiefly near the jetty at Broome.

THYONE MICRA[1] sp. nov.

Length 17 mm., diameter less than 4 mm.; body elongated, cylindrical, tapering posteriorly, oftentimes more or less upcurved at each end; completely relaxed individuals are nearly straight while those which are strongly contracted are markedly upcurved; body wall soft but moderately thick; pedicels small, very numerous, often more or less evidently in longitudinal series near the ends of the body; tentacles 10, the 2 ventral markedly smaller. Calcareous ring high, the component pieces narrow and markedly polyplacous, the radial pieces with very long posterior prolongations; from anterior tip to posterior end of prolongations, 6–7 mm. Polian vessel single, long and slender; madreporic canal not detected.

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[1] μικρός = *small*, of obvious significance.

Calcareous particles in body wall fairly abundant but not crowded; they are tables (fig. 44) with somewhat elongated stout disk, perforated with 4 symmetrically placed holes, though the disks are themselves often asymmetrical; spire of two low pillars, usually connected at the top but not rarely quite separate; each pillar terminates in 2 or 3 conspicuous teeth; height of spire scarcely equals the lesser diameter of the disk; curved supporting rods and tables in the pedicels obviously intergrade with normal tables; end-plates rather large, very coarse-meshed around the margin; introvert with many tables having larger disks, with numerous perforations, and these often become merely perforated plates; stalk of tentacles with numerous rosettes, for the most part aggregated into conspicuous heaps; branches of tentacles with very few, scattered, slender supporting rods. Anal teeth wanting.

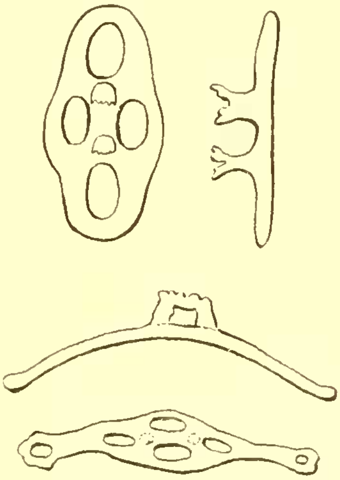

Fig. 41. Thyone micra. Tables. x 425.

Color pale brown; oftentimes five darker lines are distinguishable which may correspond with the interambulacra; the eight larger tentacles are blackish-brown, much darker than the smaller pair, which are yellow-brown; all the tentacles have on the inner surface several or many conspicuous white spots, which prove on examination to be heaps of the calcareous rosettes.

Holotype, M. C. Z. no. 1616 from a sandy mud bottom in 5–7 fms., near Pearl Shoal, Broome, W. A.

This little Thyone occurs with *T. minuta* but is not nearly so common. It is found within or under dead shells or buried in sandy-mud. I was inclined to consider it the young of *T. grisea* but comparison with a young *grisea* only 20 mm. long shows conclusively that this is not the case. The difference in the calcareous ring is conspicuous and radical, while the spires of the tables show an almost equally striking difference. The present species resembles *buccalis* in its calcareous ring but the particles in the body-wall are utterly different. It seems necessary therefore to give this little Thyone a name of its own. There are at hand only 9 specimens, showing little diversity in size; all were dredged either at Pearl Shoal near Broome or further to the southwest near or in Lagrange Bay.

THYONE MINUTA[1] sp. nov.

Length about 25 mm., diameter about 5; body cylindrical near middle, tapering a little anteriorly and considerably towards the posterior end, sometimes more or less upturned at each end in contracted specimens; body wall of moderate thickness but not at all hard; tentacles 10, of which the 2 ventral are markedly smaller; pedicels very abundant, quite small, not arranged in definite longitudinal series; calcareous ring high and thin, the radial pieces with very long posterior prolongations; entire length of a radial piece is nearly 6 mm.; it is hard to be sure whether the ring is polyplacous; apparently it is not, but owing to its thinness the pieces are easily cracked and broken, giving a somewhat polyplacous appearance. Polian vessel single, small; madreporite not detected.

Calcareous particles in the body wall fairly abundant, but not densely crowded, elongated buttons (fig. 42) perforated with 4 symmetrically placed holes and with about 18 (or fewer) small hemispherical nodules on the margin; there are also several knobs on the surface of the plate, and two of these at the center, between the perforations, are often more or less elevated into rough or spinous vertical rods; these, however, are very low and rarely show any tendency to unite to form a spire; pedicels with small curved supporting rods, some table-like, having a completed spire; end plates present, with a very coarse mesh, especially at margin; tentacles without supporting rods but with numerous rosettes and small perforated plates, more or less crowded on inner surface of tentacle stalk distally. Anal teeth wanting and anal papillae very small.

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[1] *minutus* = very small, of obvious significance.

Color, white with more or less numerous minute blotches and spots of some shade of brown; when these specks are few the animal seems to be quite white, when they are numerous, the general effect is light brown; tentacles similar, whitish and light brown. In alcohol, the color may be described as dirty whitish.

Holotype, M. C. Z. no. 1620 from sandy mud, 5–7 fms., on inner side of Pearl Shoal, Broome, W. A., June, 1932.

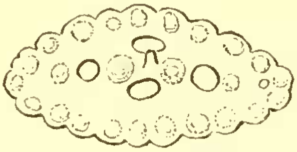

Fig. 42. Thyone minuta. Knobbed button. x 425.

This curious little holothurian is locally abundant near Broome, but in many areas seems to be quite wanting. On the inner side of Pearl Shoal where there are many dead shells on a sandy-mud bottom, *minuta* occurs in great numbers, associated with *T. micra*, which is however much rarer. The two species are easily distinguished in life by the difference in color and this is also evident in the preserved material. Of course the difference in the calcareous particles is the real ground for separation of the two forms, as well as for distinguishing them from the other Thyones. There are 148 specimens of *minuta* before me, ranging from 9 to 30 mm. in length and 3–6 mm. in diameter; even in life, specimens over 25 mm. in length were unusual. They seek the shelter of dead shells, and are quite gregarious; as many as a dozen are sometimes found on a single valve of a "pearl-oyster."

THYONE PERISSA[1] sp. nov.

Length along back about 63 mm.; length along the markedly convex ventral surface approximately 98 mm.; diameter at middle, 28 mm. Body stout, of very remarkable form; in life the trunk proper was approximately 50 mm. long, 40 mm. deep and 30 mm. thick; the anterior upper corner projected as an anterior end some 40 mm. long and 12 mm. in diameter, while the posterior upper corner projected nearly 50 mm. as an anal "snout," about 12 mm. in diameter at base but tapering to less than 8 mm. at tip; the specimen relaxed imperfectly in Epsom salts and when it was placed in alcohol, the resulting contraction greatly altered the form; it is now roughly triangular with a concave base (the back, *i. e.* the dorsal side) and a very broad and rounded apex (the center of the ventral surface). Body wall very thick and leathery. Pedicels numerous, rather large, but strongly contracted; they are not uniformly distributed over the body but show no special arrangement, the areas where they are lacking being of small size, diverse form and irregularly distributed, tho chiefly in the ventral interambulacra. Tentacles and calcareous ring wanting.

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[1] περισσός = *extraordinary*, of obvious significance.

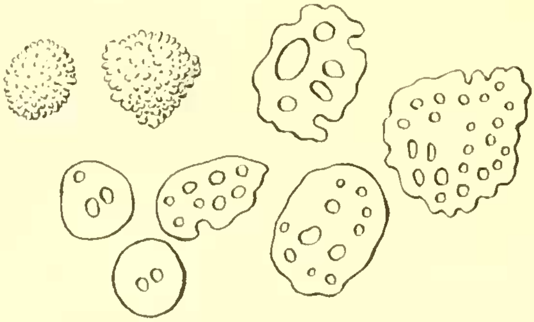

Fig. 43. Thyone perissa. Plates from body wall. x 425.

Calcareous particles in body wall very numerous, the skin being crowded with perforated plates (fig. 43) of small size and of the greatest diversity in form and in size and number of perforations; the plates themselves are only 20–50μ in diameter or in length, and have from 2 to 30 perforations, which may be very small or of relatively large size. Some of the plates are very flat and smooth while at the other extreme are rather solid rosette-like plates, of uneven thickness; the latter are rather uncommon. In the pedicels, there are no supporting rods or plates of any sort but there is an end-plate about 275μ in diameter, of rather coarse mesh. Besides a number of papillae in each ambulacrum, anal teeth are present; altho narrow they are rather conspicuous as their white color contrasts with the blackish area surrounding the anus.

Color, in life, white, more or less yellowish, especially ventrally, the numerous pedicels brown-black in sharp contrast. In the preserved specimen, the ground color is a pale buff or dirty white, and the pedicels are dull purplish-black; around the anus, the black greatly predominates, while on the sides and on the ventral interambulacra, the light color is much more prevalent.

Holotype, M. C. Z. no. 1626 from off Cape Villaret, Western Australia, in 5 fms.

This unique specimen was brought up by a diver who said he found it in a hole in a rock. Altho it was strongly contracted, and relaxed but little in Epsom salts, it did not occur to me that the tentacles and introvert were missing, until the specimen was studied in the museum two years later. I suspect now that in his efforts to pull the animal out of its hole, the diver seized the head end and pulled it off. Not realizing its importance, he discarded it and never mentioned the fact on his return to the surface. I have little hesitation in referring the specimen to Thyone, in the broad sense, but obviously not to that genus as typified by *T. fusus*. Until the tentacles and calcareous ring are known, however, we may not hope for a more definite identification. In view of the habitat, it is not strange that the species has not hitherto been taken, and it will probably be a long time before additional material is available. There is, however, no holothurian known at present with which *perissa* will be confused.

ORBITHYONE[1] gen. nov.

Thyone-like holothurians, with a stout calcareous ring of ten distinct, loosely united, pieces; five radial, broader at the blunt anterior tip than at the rounded posterior point; five interradial, nearly triangular, the anterior point, attenuate, the posterior base wide and rounded. No calcareous particles in body wall; no supporting rods but large terminal plates in pedicels; numerous rather large rosettes, and supporting rods both large and small, in tentacles.

Genotype, *Orbithyone megapodia* sp. nov.

The external appearance of these holothurians is quite like Thyone, but the calcareous ring is so fundamentally different from that of any known member of that group it seems best to make a new genus for this remarkable little species. The absence of calcareous particles in the body wall and of supporting rods in the pedicels combines with the presence of end-plates and of rosettes and supporting rods in the tentacles to make this a well defined genus, even tho only one species is at present known, which shows its characters.

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[1] *orbis* = a ring + *Thyone*, in reference to the unusual calcareous ring.

Orbithyone megapodia[1] sp. nov.

Length along back 14 mm., along convex ventral area, 21 mm.; diameter 7 mm.; anterior end contracted, blunt; posterior end with a short but evident anal projection; no anal teeth or papillae. Body wall relatively thick but not hard; pedicels relatively large and very numerous, closely covering the whole animal. Tentacles strongly contracted and difficult to make out; apparently 10, small, approximately equal. Calcareous ring very conspicuous, made up of ten large distinct pieces, only loosely joined together; radial pieces about 2.5 mm. high, rounded at blunt anterior tip, wider there than at the bluntly rounded posterior end; interradial pieces more or less triangular, about 2.5 mm. high, anterior end sharp, attenuate, posterior end nearly 2 mm. wide, convexly rounded. Polian vessel, single but moderately large; madreporic canal single, small.

Calcareous particles in body wall lacking; pedicels with no supporting rods but with large end-plates, close to which are a few small perforated supporting plates; tentacles with numerous large rosettes, both scattered and in heaps, and supporting rods; in tentacle stalk supporting rods large with widened perforated ends, not rarely tripartite; in tentacle branches, rods small, slender, and often with imperforate ends.

Color indistinctive, dull gray brown.

Holotype, M. C. Z. no. 1627 dredged at Broome, W. A., in 5–7 fms., muddy bottom, June, 1932.

The unique specimen of this interesting form is quite different from any other of the Thyone-like holothurians. The body form is quite like that of *Staurothyone distincta* but the difference in the size of the pedicels is very striking, since they are about equally abundant in the two species. The absence of posterior prolongations on the calcareous ring is also a point of resemblance but the difference in the form of the component parts of the ring is very striking. While these two new genera are thus quite distinct they are probably more nearly related to each other than to typical Thyone.

STAUROTHYONE[2] gen. nov.

Dendrochirote holothurians with 10 tentacles, the 2 ventral ones not noticeably smaller; body more or less cylindrical at middle, not conspicuously tapering towards either end; pedicels numerous all over the body, more abundant ventrally than dorsally; calcareous ring stout, both radial and interradial pieces with a conspicuous anterior point and slightly concave posteriorly, but with no prolongations on the radial pieces; calcareous particles not abundant, consisting of scattered, stout cruciform plates and more or less numerous minute rosettes; anal teeth present (in adults).

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[1] μέγας = big + πούς = a foot, *having large feet,* in reference to the big pedicels.

[2] σταυρός = *a cross* + Thyone, in reference to the very characteristic calcareous particles.

Genotype, *Staurothyone distincta*, sp. nov.

The holothurians showing the above characters are certainly not to be grouped with the true Thyones typified by *fusus*, *briareus*, etc. Besides the type species, there are three previously named forms which are congeneric. The first of these was taken at Aden and was described by Semper (1869) as *T. rosacea*. The second came from Port Philip Heads, Victoria, and was described by Bell (1887) as *Cucumaria inconspicua*. Joshua (1914) has given further information about this species which suggests that Bell's specimens were immature and that the fully grown adult would have the pedicels abundant enough to warrant calling Thyone, rather than Cucumaria. The third Staurothyone to be named was called *Thyone sargassi* by Lampert (1889) as the unique holotype was found in floating Sargassum. It does not seem to me that the slight difference in the calcareous ring and the number of Polian vessels warrant maintaining *sargassi* as distinct from *rosacea*, while the close resemblance of *inconspicua* to both warrants the suspicion that all three names refer to a single species. Until more material is available, however, and direct comparisons can be made the three names may be permitted to stand.

STAUROTHYONE DISTINCTA[1] sp. nov.

Length (quite contracted) 40 mm.; diameter about 15. Body wall moderately thick and firm, quite smooth, except for the numerous pedicels which cover it completely, but more densely ventrally than dorsally; pedicels not very slender, about .25–.30 mm. in diameter, evidently contracted. Tentacles and introvert strongly contracted, but there are evidently ten tentacles, with the two ventral scarcely smaller. Calcareous ring very stout, with radial and interradial pieces about 3 mm. high; each has a conspicuous anterior projection; the posterior margin of each piece is concave but there is no trace of any posterior prolongations. Polian vessel single, of moderate size; stone-canal single, small.

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[1] *distinctus* = separate, well-marked, of obvious significance.

Calcareous particles very distinctive, particularly the major ones which are rather uniformly but sparsely scattered in the body wall; these particles (fig. 44, a) are larger, more perfectly symmetrical and more distinctly cruciform, than those figured by Semper, Bell and Lampert for the species they described (*vide supra*); the center of the cross is more or less nearly square, and the four arms are equal and divide equally and symmetrically at the ends, into two short rounded branches, making a true "cross fourchée"; from tip to tip these crosses measure about 185μ; minor calcareous particles in the body wall are tiny rosettes (fig. 44, b) and very minute particles of irregular oblong form only 10–25μ in length (fig. 44, c); these are not at all abundant and do not form heaps as Lampert says they do in *sargassi;* in the introvert and tentacles rosettes are larger and much more abundant, and there are also very numerous, minute, slender, straight, curved, or bracket-shaped supporting rods 30–50μ long; these have insignificant knobs or branches at the tips but no perforations and some are distinctly swollen at the middle; in the pedicels, there seem to be no supporting rods except a few small ones (with expanded and perforated tips) which lie close to the large, well-developed end plates. Anal teeth well developed but not at all conspicuous.

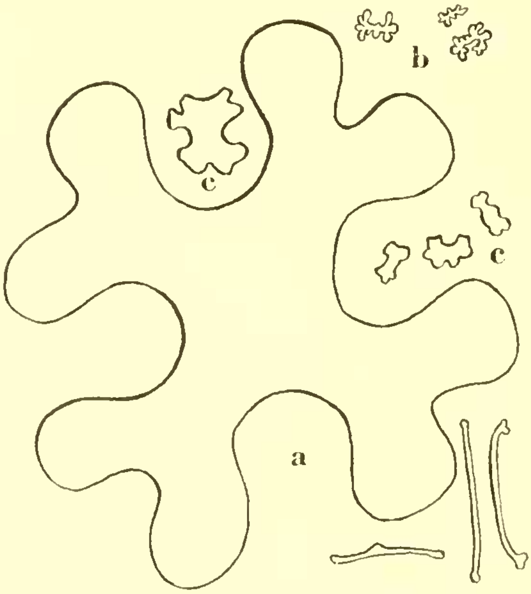

Fig. 44. Staurothyone distincta. Calcareous particles. x 425. a. Cross. b. Rosettes. c. Minute oblong particles.

Color grayish-brown, the tips of the pedicels yellowish-brown in very slight contrast.

Holotype, M. C. Z. No. 1628, dredged in 5–7 fms. near Broome, W. A., June, 1932.

A small paratype, 25 x 10 mm., also dredged at Broome in 1932, agrees in all essentials with the holotype but has the tips of the pedicels dark brown in strong contrast to the gray-brown body-wall. There is no indication of anal teeth.

This is one of the best characterized species of holothurian found in the collection. While obviously allied to *rosacea*, the calcareous particles are strikingly different, so there is no possibility of confusing it with that or any other species.

ACTINOCUCUMIS DIFFICILIS

BELL, 1884. "Alert" Rep. p. 148.

Ludwig (1888, p. 817) and subsequent writers have considered this species identical with the genotype, *typicus*, described by Ludwig ten years earlier and I have never doubted the correctness of that decision until I came to study carefully the material collected at Broome. On that part of the Australian coast, Actinocucumis is a common holothurian and 81 specimens lie before me. A very superficial examination showed there were at least two species represented and more critical study led me to believe there were three. After the lapse of several months the problem was attacked *de novo* and the belief that there are three forms of Actinocucumis found at Broome was confirmed.

Whether these should be regarded as three species or as two species and one variety is open to debate, but it is simple to regard each as a species even tho the line between the two larger forms is not as sharp as could be desired. There is no doubt that the largest and most striking form is Ludwig's *typicus*. For its closely related neighbor Bell's name *difficilis* may well be retained on the ground of the difference in color: *typicus* is, as a rule, a very distinct brown, often quite bright, Ludwig says "einfarbig braun;" *difficilis* is, as a rule, more or less "purplish-gray" as Bell says of some of his specimens — unfortunately he does not say how many he had, but it seems quite possible that some of them were really *typicus*, as he says "some were light brown," and none of my *difficilis* from Broome would be called brown.

The following key will indicate the grounds on which I am recognizing three species in what has hitherto been considered a monotypic genus.

Key to the Species of Actinocucumis

A. Size large, adults 75–135 mm. long, 15–30 mm. in diameter; pedicels, especially dorsally, rather short and thick, usually few and short around the anus; supporting tables in pedicels numerous, stout, often with a high spire; no delicate biperforate plates.

Color ranges from a dirty whitish or pale gray to a deep purplish-gray, darkest on the interambulacra, which often contrast strongly with the much lighter ambulacra; small branches of the tentacles usually similar to the dark interambulacra but may be noticeably darker. Pedicels of moderate size and length, numerous near and around anus; small imperfect ones of the dorsal interambulacra usually few and inconspicuous. Body wall moderately firm but not rigid . . . . *difficilis*

Color typically uniformly brown with a reddish tinge, the interambulacra not conspicuously different from the ambulacra; some large individuals, however, are dull purplish-brown; small branches of tentacles usually very dark, sometimes nearly black but sometimes bright brown. Pedicels large, stout and short, especially on the dorsal side, where small, imperfect ones are also rather numerous; at the posterior end of the body, pedicels are few and inconspicuous. Body wall often rigid from the amount of calcareous material . . . . *typicus*

A^1. Size small, adults 50–80 mm. long, 7–10 mm. in diameter; pedicels long and slender, even dorsally, sometimes conspicuously so, and distinctly so near anus; supporting tables in pedicels few, with a relatively slender rod-like disk and low spire; delicate biperforate plates common, particularly in and near the pedicels . . . . *longipedes*

In all the members of the genus, the tentacles contain large quantities of supporting rods of very diverse form and size, and in the stalk there are numerous tables with elongate, multiperforate disks and high (or low) spires; small perforated plates, and even rosettes, are also to be found in the quantity of calcareous material. In the pedicels the abundance of calcareous particles and supporting tables makes complete retraction difficult, but the terminal plates, while sometimes evident enough, are usually small and difficult to discover. The calcareous ring shows no constant differences in the three species nor is there any very striking difference between young and adult. Ludwig's figure (1874, pl. VII, fig. 24d) is good and seems to me more satisfactory than Ekman's (1918, pl. IV, fig. 44); indeed I have not seen in the considerable number of specimens I have examined a single case where the posterior part of the ring is as high in comparison with the anterior projections as Ekman draws it.

There is no doubt that the line of division between *difficilis* and *typicus* is unsatisfactory. Typical examples of the two are very different and easily recognized, regardless of size, but specimens of *typicus* which are dull purplish-brown may be misleading. The best single test is the character of the pedicels around the anus. In *typicus* they are, in each ambulacrum, few and low, usually not even one close to the opening. In *difficilis* on the other hand there are commonly several normally large ones, and a number of small ones, in the terminal part of each ambulacrum. In general, *difficilis* has smaller pedicels than *typicus* and they are much more numerous and crowd the ambulacra more. This is true regardless of size but there are exceptions even among adults. Specimens of *difficilis* only 25 mm. long are generally distinguishable at a glance from specimens of *typicus* of the same size, by the color and the size and number of pedicels.

In the vicinity of Broome, *difficilis* is much more common than *typicus*. Most of the 26 specimens at hand were dredged in 5–7 fms. of water but now and then a specimen was taken at extreme low tide. They range in size from 15 x 3 mm. to 100 x 15 mm. and the diversity of color has already been pointed out in the "key." One or two are so light colored they must be called "dirty white," tho the branches of the tentacles are distinctly yellow-brown; there is no appreciable amount of pigment even on the interambulacra. But the great majority of the specimens are "purplish-gray" of some shade, commonly quite dark, at least on the interambulacra.

ACTINOCUCUMIS TYPICUS[1]

LUDWIG, 1874. Arb. Zool-Zoot. Inst. Wurzburg; **2**, p. 91.

The specimens from Broome which represent the typical member of the genus are not numerous (12 in all) but range in size from 26 x 6 mm. to 135 x 30 mm. With the exception of one large specimen which is dull purplish in color instead of brown, they form a very homogeneous series. The characteristic color is very near walnut-brown (cf. Ridgway's Code) but of course few individuals are exactly that shade. As a rule the tentacles are much darker, sometimes almost black, but in some individuals they are the same shade as the body-wall, and in at least one case they are considerably lighter. There is little or no difference in shade between the ambulacra and interambulacra. The two largest individuals were found on the beach south of the jetty at Broome, one, at least, washed up by the surf; the larger measured nearly 175 mm. long in life, so the shrinkage on preservation was over 20%. The smallest specimen was found embedded in a sponge brought up by a diver from 5–7 fms. of water. Several specimens were dredged and two of these were taken off False Cape Bossut.

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[1] Ludwig called his species *typica* but Ekman (1918) has pointed out that *cucumis* is a masculine noun — *typicus* is the correct form. The date of Ludwig's paper is commonly given as 1875 — Ludwig himself calls it 1874.

ACTINOCUCUMIS LONGIPEDES[1] sp. nov.

This is a smaller and more slender species than either of the others but not so different as to require a carefully detailed description. The 44 specimens at hand range from 15 x 3 mm. to 80 x 100—the last, however, is really a giant, no other specimen measuring over 70 mm., and the great majority are under 50.

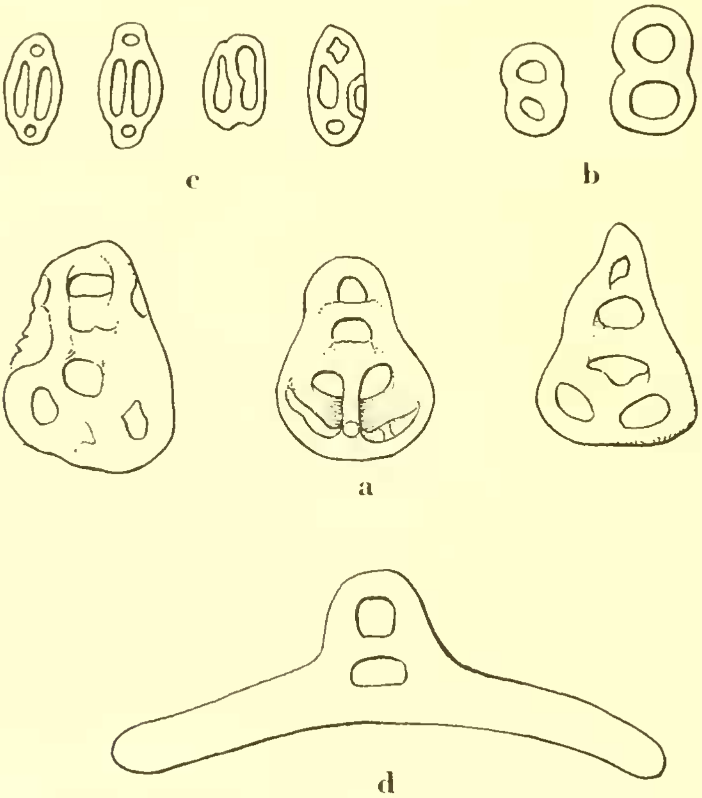

Fig. 45. Actinocucumis longipedes. Calcareous particles. x 425. a. Pear-shaped bodies. b. "Acorns." c. Flat plates. d. Supporting rod from pedicel.

The color shows some diversity: the largest specimen is a uniform dark fawn color, others are a still darker shade of the same, but the great majority are a deep purplish-brown or brownish-purple. The tentacles are usually very dark, sometimes almost black. Even the lining of the body cavity and the muscles partake of this dark color in some of the present specimens, but this may be a post mortem effect. The calcareous ring is not essentially different from that of *typicus* but seems to be a little less heavy.

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[1] *longipedes* = having long feet, in reference to the notably long pedicels.

The most striking feature of the species is the length of the pedicels, even in preserved material. Apparently they are not easily retracted and in several individuals they are still 3 mm. long, with a diameter of about one-third as much. They are arranged in 2 or more series on each ambulacrum; in the largest individual they are quite definitely in 2 series but in other specimens there are fully 4 series indicated. Near the anus they are as long and numerous as elsewhere.

The calcareous particles are fundamentally like those of the other species but show some characteristic features. The so-called "acorn-shaped" bodies are usually sufficiently flattened so that they resemble the figure 8 (fig. 45, b) and are about equally wide at the two ends; it is quite unusual to have one of the ends pointed or with a projection as is usually the case in the other species. Scattered freely among the myriads of "acorns" are pear-shaped bodies (fig. 45a) which are abruptly much larger; these are fairly numerous and seem to be wanting in *typicus* and *difficilis*. Perhaps it would be better to say that in these two species the pear-shaped bodies are larger and coarser and intergrade so completely with the supporting tables of the pedicels that they lack the distinctive character which they have in *longipedes*. For in the new species the supporting tables (fig. 45, d) are relatively few, with long bases and low spires, and do not intergrade with the pear-shaped bodies. Most distinctive of all the characters in *longipedes* is the presence of rather delicate, flat plates (fig. 45, c) having two elongated, parallel perforations; these are about as long and wide as the "acorns" but the solid parts are much more slender. They are fairly common everywhere, especially near or in the pedicels, but the "acorns" are probably a hundred times as numerous. I have found nothing like them in either of the other species and neither Ludwig, Bell, Ernst nor Ekman make any reference to them, so apparently they are not found in those species.

This new Actinocucumis (holotype, M. C. Z. no. 1632) was met with frequently both in 1929 and 1932, but was usually secured while dredging in 5–7 fms. of water. Unfortunately they were supposed to be the young of the larger species and no adequate attention was given to the conditions under which they occur.

PSEUDOCUCUMIS AFRICANUS

Cucumaria africana SEMPER, 1868. Holothurien, p. 53.
Pseudocucumis africanus LUDWIG, 1888. Zool. Jahrb. Syst., **3**, p. 815.

This unmistakable species is represented by a series of 14 specimens taken on the coast of Queensland, at Darwin, at Cape Leveque and near Broome. It is thus evidently distributed all along the tropical coast of Australia. In the vicinity of Broome, it is rather common on the under side of rock fragments in tide pools and near low water mark. It clings tightly to the rock and its dark coloration makes it very inconspicuous. In life, the color seems to be purplish black with the pedicels darker than the body wall but in alcohol the color becomes lighter and ranges from blackish brown to a rather definite yellowish brown, the pedicels and tentacles remaining darker. Mitsukuri (1912) says that the ventral surface is yellowish but I have seen no specimens in which there was, even in life, any marked difference between the upper and under sides. In some individuals the characteristic big calcareous disks in the body wall are evident under a lens but this is not always the case. In size this holothurian ranks among the small species; Semper gives the length as 40–48 mm. and Mitsukuri (1912) says 70 mm. is about the maximum. The largest specimens I have ever seen are in the present series and were taken at Masthead Island, Queensland; they are now 30–35 mm. long and nearly 10 mm. in diameter and in life may well have exceeded 40 mm. A specimen from Broome is nearly 35 mm. long but it is only 5–6 mm. in diameter.

The material before me comes from the following localities:

Queensland: Masthead Island, October, 1910. J. A. Kershaw leg. 2 large specimens. Loan from Victoria National Museum.
Norwest Islet, July, 1929. Ward and Boardman leg. 1 specimen. From Australian Mus.
Port Denison. 1 small specimen labelled "Orcula cucumiformis Semp. God. Colln." Loan from Victoria National Museum.
Northern Territory: Darwin, East Point, under a rock, July 26, 1929. 1 specimen.
Western Australia: Cape Leveque, August 21, 1929. 1 specimen.
Broome, August and September, 1929. 8 specimens.

PSEUDOCUCUMIS INTERCEDENS

Plate 16, fig. 6

LAMPERT, 1885. Die Seewalzen, p. 254.

In my account of the individuals of this species taken by the Great Barrier Reef Expedition (1932, p. 226) I made the statement that *intercedens* was not reported between 1886 and 1918. This is an error which is corrected by Engel

(1933, p. 37) in his admirable revision of the holothurians which have been referred to Pseudocucumis. But it remains true that little was added to our knowledge of this species until Ekman's (1918) careful account of material from northwestern Australia.

The material now before me is of no little interest and importance for two reasons. In the first place it furnishes convincing evidence that the species which I described in 1921 from Torres Strait under the name *eurystichus* is not valid and that name is to be regarded as a synonym of *intercedens*. In the second place one of the specimens in hand is so large as to suggest that all the specimens hitherto known were immature.

The species *eurystichus* was supposed to be distinguished from *intercedens* by wider ambulacra with more pedicels, and by a heavier calcareous ring with distinct posterior prolongations on the radial pieces. Several of the specimens from Broome have the ambulacra as wide and the pedicels as numerous as in the single known specimen of *eurystichus*. As for the calcareous ring, the posterior prolongations of the radial pieces are at first sight obvious enough in all specimens but on a more careful examination they are seen to be cartilaginous; even in small specimens this is obvious enough. The type of *eurystichus* is a small individual and the calcareous ring is essentially like that of the specimens from Broome, but there does seem to be some calcification in the proximal part of the cartilaginous prolongations; in the published figure (H. L. Clark, 1921, pl. 37, fig. 9) I have failed to make any distinction between calcareous matter and cartilage, hence the figure is quite misleading. Ekman's (1918) figure 58 is more accurate, for he omits the cartilage altogether, though it is very conspicuous in the specimens.

The most interesting of the individuals at hand is a huge one, gotten by a diver, in 7–8 fms. of water, which measures 115 mm. in length and nearly 40 in diameter; the dorsal side is nearly straight but the ventral is strongly convex. The pedicels are more numerous in the ventral ambulacra than in the dorsal, where they are rather irregularly scattered and widely spaced. All of the specimens of *intercedens* hitherto known have been less than 75 mm. long and nearly all are under 50 mm. They have been taken for the most part in shallow water, under rocks, among sponges or in similar sheltered places. The absence of adults hitherto may be due to the fact that as they mature they seek deeper water and more inaccessible hiding places from which a dredge cannot dislodge them. A diver, however, can get them out of such holes or crannies and bring them to the surface. That is how I was fortunate enough to secure so fine an adult. It is worthy of note that this specimen seems to have but 23 tentacles, and not one of the others examined has 30. There is one with 28 expanded tentacles, but that is much the largest number I have noted; all the other specimens have the tentacles introverted and some have not been cut open. The three smallest specimens are only 8–10 mm. long; the smallest has the tentacles fairly well expanded and there are but 12.

All of the specimens show the same striking coloration. As Ekman (1918) has pointed out, from a sketch of Mjöberg's, the color in life is very handsome; the interambulacra are dark blue-violet or nearly black, while the ambulacra are bright red in striking contrast, with the pedicels yellowish-red; the color of the pedicels naturally varies with the degree of contraction; when fully contracted they are quite red; the stalks of the tentacles are light colored but the branches are very dark. In alcohol, the red tints disappear entirely and the ambulacra are dirty whitish but the contrast with the interambulacra is as striking as ever. In the huge adult, the interambulacra are brown, not nearly as dark as in the small specimens, and the lines of division between them and the ambulacra are not so sharply defined. On the whole whether alive or in alcohol, *intercedens* is one of the most striking and easily recognized of the holothurians of tropical Australia.

The material in hand is all from Broome and consists of 6 specimens taken in 1929, of which 3 are very small, and 4 specimens taken in 1932, of which 1 is very large. With the exception of the largest, which as already stated was brought up by a diver, they were collected under rocks, or among sponges, in tide pools or near low water mark, or they were dredged on shelly bottoms.

PSEUDOCUCUMIS THOMSONI

Cucumaria thomsoni HUTTON, 1879. Trans. N. Z. Inst., **11**, p. 307.
Pseudocucumis thomsoni MORTENSEN, 1925. Vid. Med., **79**, p. 355.

There are three holothurians in hand which had best be referred to this New Zealand species, redescribed and figured by Mortensen with his customary care. In nearly all essentials, the agreement is striking but there are certain differences which must at least be mentioned. Mortensen's figure of the whole animal shows a rather stout, dark colored holothurian about 55 mm. long by 15 mm. in diameter, with numerous small, whitish pedicels, arranged in 5 or 6 series on each ambulacrum, quite in accord with Hutton's original description. My specimens are rather slender, nearly cylindrical, pale gray holothurians, with the whitish pedicels of a relatively considerable size, arranged for the most part in two, or rarely three, series in each ambulacrum. But these individuals are considerably smaller than Mortensen's, as they are only 25–40 mm. long, and not over 6 mm. in diameter. They give the impression of having been white when taken, the tentacles perhaps more gray. It is not impossible that they may have been darker in life but it is hard to believe they were ever brown. One of the specimens has 24 tentacles, of which the dorsal pair seems to be smaller than the adjoining pairs of large tentacles, as is stated by Mortensen; in another specimen there seem to be 23 tentacles of which 14 or 15 are large; in the third specimen, I am not able to count more than 20 tentacles, of which 12 may be called large.

The calcareous ring and the calcareous particles of the Australian specimens are so much like those of the New Zealand form that no differences of importance can be mentioned and it is on this account that I am ignoring the differences in color and form, and in the arrangement of pedicels. It is a matter of no little interest that the range of this apparently well-marked species should be extended to Tasmania and Western Australia. Particular thanks are due to Professors Flynn and Bennett, who presented me with the specimens.

Western Australia: East of Point Culver, lat. 33° 15′ S. x long. 126° 22′ 15″ E.,
90 fms., Feb. 23, 1930. D. L. Serventy leg. 1 specimen.
Tasmania: Hobart, D'Entrecasteaux Channel, 5 fms. T. T. Flynn leg. et don.
2 specimens.

PHYLLOPHORUS BROCKI

LUDWIG, 1888. Zool. Jahrb. Abth. Syst., **3**, p. 813.

Among the specimens sent by Mr. Bardwell in 1933 are four holothurians, which seem to belong to this East Indian species. The calcareous spicules in the body-wall are so unlike the figures given by Ludwig that I should not have thought of referring this material to his species but Dr. Deichmann, who kindly studied it carefully, pointed out that Sluiter's figures (1914, figs. 5a–d) are much more different from Ludwig's than are the spicules in the specimens at hand. She suggested that none of the published figures are reliable, since they are obviously free-hand drawings and not made with a *camera lucida*. Ludwig's figure 23 shows the perforations in the plates much too small, while Sluiter's figure 5b shows them much too large. Figures drawn with a camera lucida are given herewith (fig. 46) and it is evident that if Sluiter's specimens are really the same species as Ludwig's, the

Australian specimens should be assigned to *brocki*. But as it seemed possible that actual comparison of specimens might show that we are really confusing two (or possibly three) quite different holothurians under one name, I asked Dr. Engel at Amsterdam if he would loan me one of Sluiter's specimens. With the greatest kindness, he has done far more than this for he at once sent me six of the "Siboga" specimens and also the huge specimen taken by the "Gier" and described by Sluiter in 1914. The examination of this material has been most interesting and shows conclusively that my Australian specimens are identical with those taken by the "Siboga." One of the latter, however, a rather small, light-colored individual taken at Station 220, has very distinctive calcareous particles, quite different from those of typical *brocki;* it should probably be treated as a separate species. The specimen taken by the "Gier" in 24–29 m. east of Sumatra is so much larger than any of the other available specimens, it is difficult to make a satisfactory comparison with them. Sluiter's description sets forth the main morphological features sufficiently but his figures are not very satisfactory, being hardly more than hasty sketches. After a prolonged comparison with the other specimens, I am inclined to think Sluiter is correct in calling it *brocki*. It appears to be a senescent specimen, the calcareous ring and the particles in the skin showing regressive changes. The tables show this most markedly but not incredibly, and smaller individuals show occasional tables very much like them.

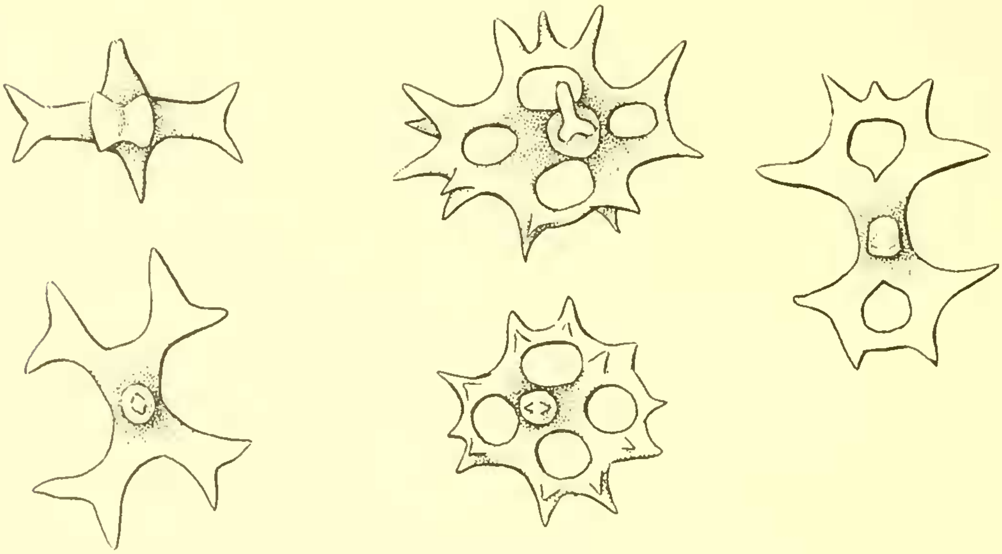

Fig. 46. Phyllophorus brocki. Calcareous particles. x 425.

The question whether these holothurians called *brocki* by Sluiter are identical with the species so named by Ludwig is another matter and not easy to determine unless Ludwig's type can be reëxamined. It is hard to believe that as careful an observer and as good an artist as Ludwig could ever have drawn the very characteristic particles of the "Siboga" specimens as thick plates with very small perforations and irregular margins, shown in his figure 23. It is even more difficult to understand how he could say they have "eine grosse Aehnlichkeit" to those of *Thyone curvata* Lampert.

The Australian material at hand consists of four specimens taken at Augustus Island, northwestern Australia, in October, 1933, by Captain Beresford E. Bardwell. They range in size from 34 x 12 mm. to 100 x 30; all are, however, quite contracted and the size in life must have been somewhat larger. The color is dull brown, distinctly light yellowish-brown in one individual. The relatively large pedicels are not very numerous, and have the tip distinctly dark, often deep violet as mentioned by both Ludwig and Sluiter; in the yellowish-brown individual, the tips of the pedicels are not particularly dark. As a rule the pedicels are not completely retracted and the heaps of rosettes in their walls appear under a lens as white spots. In combination with the dark tips this makes the pedicels an excellent recognition mark for the species. In the largest specimen, the calcareous ring is more or less imbedded in cartilaginous tissue, but in the smallest, there is very little evidence of cartilage, and the radial and interradial pieces resemble very closely the figure referred to by Ludwig. It is noteworthy that no specimen of *brocki* was secured either at Broome or Cape Leveque.

PHYLLOPHORUS CEBUENSIS

Thyonidium cebuense SEMPER, 1868. Holoth., p. 67.
Phyllophorus cebuensis LUDWIG, 1892. Die Seewalzen, p. 347.

There is a single small holothurian from Dongarra, W. A., which is so like Semper's figures and very incomplete description of this species that I can find no character by which to distinguish it from the Philippine Islands' form. It is only 15 mm. long by about 6 mm. in diameter, but in color, form and distribution of pedicels it is exactly like Semper's figure. The calcareous ring is very similar to that figured by Semper, but the posterior prolongations of the radial pieces are turned inward so abruptly that one might think they are absent; this is apparently due to strong muscular contraction of the oral disk and oesophagus. The number of tentacles is difficult to make out but there are more than a dozen;

they show much diversity in size and the arrangement cannot be determined; the specimen is obviously immature and the oral end is strongly contracted. The pedicels have large end plates with a few narrow, curved, perforated plates close by, but there are no supporting rods. The tables in the body wall are few and well separated; they are of the size and form indicated by the very simple and imperfect figure of Semper; the disk has a somewhat less even margin than he shows and the low spire has an annular crown, somewhat rough or finely spinous, the diameter of which is fully a third of the disk diameter. Both the calcareous ring and the tables are much more like Semper's figures than they are like those given by Sluiter (1914, pl. 1, figs. 10a, b) for a specimen taken in the Java Sea, but I am skeptical about the latter really being *cebuensis*.

The occurrence of this East Indian species, so far down on the western coast of Australia is very interesting. It was taken in shallow water by students of the University of Western Australia, while on a summer excursion to Dongarra, and was very generously given to me by Professor E. W. Bennett.

Phyllophorus proteus

Bell, 1884. "Alert" Ech., p. 150.

It is apparent that Bell examined the calcareous particles of a young individual but he gives no indication as to its size. As I have explained elsewhere (H. L. Clark, 1921, p. 168), his figure of the calcareous ring is inaccurate as well as upside down, while his description of the calcareous particles in the body wall is very unsatisfactory and the figure given represents only the disk of a young table. In adult specimens very few of the tables are as simple and symmetrical as Bell's figure, and the rosettes, which he refers to as "spicules in the suckers," are very abundant in the body wall everywhere. I have compared my material with one of Bell's types and find that the specimens taken at Darwin are almost exactly like it. Of the larger of these, my field notes say: "A curious dull red, plump, ovoidal creature about 100 mm. long by 40 mm. in diameter, dredged July 19 (1929) near Three-and-a-half-mile Reef, on dead bottom. The distinctly red (brown-red) color is more or less masked by dusky blotches and fine sprinkling. No tentacles were ever extended but pedicels 2 mm. or more in length were relaxed all over the body; these usually have dusky or brown tips." This specimen is now (in alcohol) about 60 mm. long by 25 in diameter; under a lens, the ground color is dirty white with numerous very fine irregular transverse lines of brown; the pedicels, which are abundant ventrally but less so dorsally, are whitish at the base, but pale brown distally with the tips abruptly dark brown or blackish. The other Darwin specimen is similar. The Augustus Island specimen is more distinctly brown and more of the tables have enlarged or irregular disks. The individuals taken at Broome have the ground color, especially on the back and sides, dark gray or dull purplish in rather strong contrast with the light colored pedicels; the tips of the latter are dark but not in such abrupt contrast as in the Darwin material. The tables while often typical, show a great deal of diversity both in disk and spire; many have the disks larger, more irregular and with more perforations. The rosettes, as well as these larger tables, seem to be undoubtedly more abundant in the larger specimens. The material at hand, 7 specimens, was taken at the following localities:

Northern Territory: Darwin, dredged near Three-and-a-half mile Reef, 2–3 fms.,
"dead" bottom, 2 adults.
Western Australia: Augustus Island, 1 adult.
Broome, 4 specimens, 33–65 mm. long.

PHYLLOPHORUS PARVIPEDES[1] sp. nov.

Length 90 mm.; diameter about 15 mm. Body elongated fusiform, the anterior end a little stouter and blunter than the posterior; body wall thin but rather firm; pedicels, numerous relatively very small, without any tendency to longitudinal arrangement, smallest and most numerous just back of the middle of the ventral surface; there are some minute anal papillae but no anal teeth. Tentacles retracted and difficult to count to apparently 17, of which 10 are large and 7 are small, but their relative arrangement is quite asymmetrical.

Calcareous ring stout and characteristic; radial pieces oblong, about equally wide throughout, 3 mm. long by 2.5 wide, the anterior end rounded and notched; there are two stout posterior prolongations over 8 mm. long, each consisting of about 8 pieces of which the uppermost is 1.5 mm. wide, the others smaller and together tapering rapidly to a narrow flexible tip; interradial pieces conspicuous, high pentagonal, truncate posteriorly, 2.5 mm. wide and over 3 mm. high; including the slender very acute anterior processes, they overlap the radial pieces on each side very markedly. Polian vessel single, long and conspicuous. Madreporic body single, small and nearly spherical.

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[1] *parvus* = small + *pedes* = feet, in reference to the small pedicels.

Calcareous particles in the body wall, scattered tables (fig. 47), not numerous but most so near the pedicels, with a disk, when complete, having four central perforations, a distal ring of 8–12 somewhat larger ones, and 8–10 marginal spines; spire well developed but small, its height nearly equal to half the diameter of the disk; it terminates in a ring bearing about four (3–6) long, more or less flaring spines. Few of the tables are completely or symmetrically developed; some of the marginal perforations are not closed in and the series is thus incomplete or even lacking; in such cases (probably young tables) the four central perforations may be larger than in the complete disks; the marginal spines are usually a conspicuous feature but their number and length, and the plane in which they lie show great diversity; in some tables there are short spines directed straight downward from the lower surface of the disk but it is difficult to demonstrate their presence unless the table is seen from the side; the height and completeness of the spire show great variety, the tables near and in the pedicels tending to have it much reduced. Complete tables have the disk nearly or quite 100μ in diameter with the spire about 40–50μ high and the diameter of its crown 30–70μ according to the length of the flaring spines. Senescent tables have the marginal spines of the disk reduced to mere rounded projections and the spire reduced in height but with its terminal teeth relatively very much enlarged. Near the anus the tables undergo an apparently hypertrophic development and become transformed into hemis-

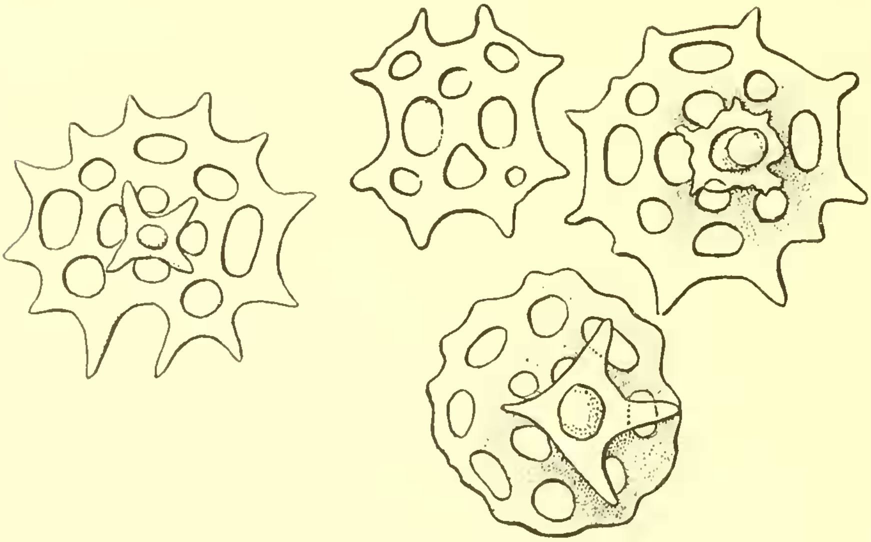

Fig. 47. Phyllophorus parvipedes. Calcareous tables. x 425.

pherical or spherical fenestrated masses; all stages can be found between normal tables and fenestrated spheres without any resemblance to a table.

Pedicels with very complete terminal plates accompanied by a number of broad supporting plates having numerous perforations; introvert with a few miliary rosettes; tentacles with numerous rosettes and very numerous, small and exceedingly slender supporting rods; these are not quite straight and each end is enlarged and often notched or perforated; frequently there is a swelling at the middle also.

Color whitish or pale gray, more or less tinted here and there with yellow brown, with numerous irregularly disposed blotches (2–10 mm. across) of red brown or blackish-brown; pedicels for the most part correspond in color to the area where situated; tentacles rather light, variegated gray and yellow-brown.

Holotype, Australian Museum No. J6041, from Broome, 1930. Unfortunately there is no indication whether the specimen was dredged, or collected along shore. It was sent to the Australian Museum by Mr. R. A. Bourne with some other holothurians from Broome, including a second specimen of this species. This paratype is 53 mm. long by 12 in diameter, considerably contracted and hence with a thicker body wall than the holotype; the blotches are all rather small and not at all reddish brown but dusky with a tinge of purplish; many of the pedicels are distinctly orange-red at tip but owing to their small size this is not conspicuous; the calcareous ring and tables agree almost exactly with those of the holotype.

In my collections from the vicinity of Broome are two small holothurians which I think must be referred to this species, although the texture of the body wall and the coloration are very different. One of these, taken at Broome in 1929, is about 60 mm. long by 15 in diameter; the body wall is thin but not delicate; rather small pedicels are relatively few and well scattered over the body, but are most abundant ventrally; the color is pale gray with the tips of the pedicels dull yellow; the calcareous ring has the posterior prolongations somewhat less well developed and the tables have the disks with very conspicuous marginal teeth — but both these characteristics are obviously youthful traits; perhaps the absence of dark blotches may be interpreted in the same way. — The other specimen is still younger and more delicate. It was taken in Beagle Bay in 5 fms. of water, June 17, 1932. It is now light gray in color and about 16 mm. long by 4 mm. in diameter. The body wall is very thin and the pedicels few and scattered, showing no indication of a longitudinal arrangement. My field notes say of this specimen: "A very thin-walled, translucent white thing 30–35 mm. long, 4–5 in diameter; covered with shell fragments, etc.; dredged on a weedy, muddy bottom (sandy mud)."

So far as I can discover, no Phyllophorus very much like this species has yet been described. It obviously belongs in the same group with *cebuensis* and *proteus*, but the tables are very distinctive, and the calcareous ring is equally characteristic.

PHYLLOPHORUS THYONOIDES[1] sp. nov.

Length 42 mm., diameter about 15; whole animal strongly contracted, making the body-wall nearly two millimeters thick and rather fleshy. Pedicels numerous, of moderate size, rather uniformly scattered over the body surface; there are no noticeable anal papillae and no anal teeth. Tentacles 16, curiously enough fully relaxed and turned inward down the oesophagus; the tips are literally swallowed; 13 are large, 10–15 mm. long, and only 3 are distinctly small. Calcareous ring, very well developed, but made up of many rather large, irregular plates; radial pieces, about 10 mm. high, with posterior prolongations extending back some 5 mm. further; anteriorly each piece is made up of a single element, nearly 5 mm. high and 3 mm. wide, deeply grooved and notched at the upper margin; posterior to this follow about 8 closely united, irregular pieces, following which are the prolongations of each side consisting of three or more calcareous pieces and considerable cartilage; interradial pieces made up of 10–12 elements of which the anterior is the largest; it is fully 4 mm. high and 2.5 wide at base, narrowly triangular with an acuminate anterior tip; posteriorly some small elements of the interradial pieces seem to help form the basal part of the posterior prolongations; obviously the lines of division between radial and interradial pieces of the calcareous ring are indefinite and arbitrary. Polian vessel single and rather conspicuous. I have failed to find a madreporic canal.

Calcareous spicules in the body wall consist of rather scattered, but by no means rare, tables (fig. 48, a) with disks about 100μ across; the spire is usually incomplete and its height is only about half the diameter of the disk; when the spire is complete it is more rectangular than circular. Many of the tables are very imperfect, even the disk being only partially developed. In the basal part of the tentacles, and also near the anal margin, miliary granules or rosettes occur but they are not abundant in any of the specimens examined. Pedicels with large terminal disks, surrounding which are a number of wide, perforated supporting plates. In the tentacles, especially the base of the large branches, are big supporting rods (fig. 48, b) with the ends abruptly widened, perforated and branched;

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[1] *thyonoides* = like Thyone, in reference to the resemblance to some members of that genus.

there are also some much smaller and more slender rods, especially in the branches. Color brown, but fragments of a much darker epidermis are to be found here and there.

Holotype, M. C. Z. No. 1654, from beach drift, Cottesloe, Western Australia, July, 1926, L. Glauert leg.

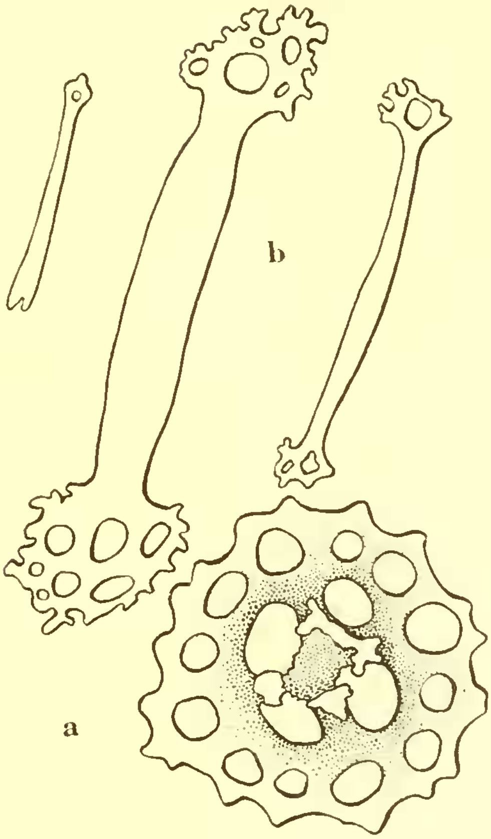

Fig. 48. Phyllophorus thyonoides. a. Table. b. Supporting rods. x 425.

There are four paratypes, taken at the same place and time; these are not quite so large and are in less satisfactory condition on the whole, but in two of them much more of the epidermis is present and the pedicels are in better shape. These individuals show that in life the color is a blackish-brown, perhaps nearly black, and the pedicels are numerous and cover well the whole body surface. Not one of the specimens has 20 tentacles; in the four paratypes the tentacles are strongly contracted and the number and relative size are hard to make out but apparently there are 13, 14, 15 and 18. I see no reason, however, to doubt that the normal number in adults is 20.

As these specimens were collected and preserved with a large number of specimens of *Lipotrapeza vestiens*, they were at first supposed to be that species, but the dark color of two individuals led to their being critically examined, when the presence of tables and the striking calcareous ring demonstrated their distinctness. The whole lot was then carefully looked over and the five specimens of Phyllophorus were discovered. It was then supposed that they might be referred to *cebuensis* but comparison with the specimen of that species from Dongarra negatived that hope. The resemblance of the tables to those of *trapezus* led to referring them to that species but comparison with two paratypes of *trapezus* shows that they may not be referred to that Queensland species; the difference in the calcareous ring and in the supporting rods of the tentacles are too weighty to permit confusing the two. Apparently then *thyonoides* should be regarded as the west coast representative of the *cebuensis* group of Phyllophorus. Better material is much to be desired but will probably only be obtained by dredging in moderately deep water off the western coast of Australia, south of Geraldton. The five specimens at hand were loaned by the Western Australian Museum and as already stated were gathered from beach drift at Cottesloe in July, 1926.

LIPOTRAPEZA[1] gen. nov.

It is a curious fact that three species of holothurian, occurring on the southern coast of Australia and referred by their describers to the genus Phyllophorus, lack calcareous tables in the body wall, and it seems to me it would be well to separate these from the forms possessing tables. One of these is a New Zealand species based on a single specimen from Akaroa, named by Dendy and Hindle (1907) *dearmatus* because of the lack of calcareous spicules. Joshua (1914) reports this species from the coast of Victoria but gives no information about the four individuals recorded. I have never seen a specimen but Mortensen has given a brief account (with important figures) of two taken in Wellington Harbour; the presence of tables at the anal tip of the body is reported and figures of them are given. The calcareous ring, which is the most important diagnostic character of the species, is carefully figured. In 1914, Joshua gave a description of another Phyllophorus lacking spicules in the body wall, which he named *vestiens*. His notes on the color and appearance in life are interesting and important. The following year Joshua and Creed (1915) described a closely related species, *ventripes*, from the coast of South Australia (presumably St. Vincent Gulf), which is distinguished from *vestiens* by the peculiar distribution of the pedicels. In both species the calcareous ring is stout with well developed but rather short processes on the radial pieces.

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[1] λίπο = *to be lacking* + τράπεξα = *a table*, in reference to the deficiency of calcareous tables in the body wall.

Specimens of both these Australian species are before me; many specimens of *vestiens* and a single paratype of *ventripes*. Some additional information can therefore be given about each which confirms my belief that they may well be placed in a genus by themselves. The New Zealand species differs so conspicuously from them in its calcareous ring that it can hardly be placed in the same genus, especially since it has tables in the anal tip of the body. It may ultimately be placed in a genus by itself, when sufficient material is available. The diagnosis of Lipotrapeza is as follows:

Dendrochirote holothurians with 20 tentacles, 10 large and 10 small as in Phyllophorus; pedicels numerous, more or less widely distributed without definite arrangement; calcareous ring stout with conspicuous, but not elongated, posterior processes on the radial pieces; no calcareous material in the body wall, but more or less numerous rosettes and perforated rods in the introvert and also in some cases, at the anal tip of the body, where tables also occur in some individuals; pedicels with end plates and a few, perforated supporting rods.

Genotype, *Phyllophorus vestiens* Joshua.

The two species of the genus may be readily distinguished from each other as follows:

Pedicels abundant on middle of lower surface, much less abundant anteriorly and posteriorly, and nearly or quite wanting on middle of back . . . . *ventripes*

Pedicels very numerous all over the body with little distinction between dorsal and ventral surfaces . . . . *vestiens*

LIPOTRAPEZA VENTRIPES

Phyllophorus ventripes JOSHUA and CREED, 1915. Trans. Roy. Soc. S. Austral., 39, p. 19.

A paratype of this species has been loaned me by the South Australian Museum and has been examined with much interest. It is about 50 mm. long by 18 in diameter and the body form differs from the figured holotype in having the anal end more prolonged and slender. The distribution of the pedicels is also different, for they are by no means "restricted to the midventral region," though they are much more abundant there. There are many all over both ends of the animal and along the sides; they are not wholly lacking on the dorsal surface but they are few and far between there, and there are small areas which lack them altogether. In the matter of the spicules, too, this specimen differs from the original description, for while it is true that the body wall lacks them throughout most of its area, they are present in the introvert and at the anal tip of the body; there are no tables, but there are many rosettes and also many rods with more or less expanded and perforated ends; some of these rods are almost perforated plates, so broadly are the ends expanded. Besides the end plate many of the pedicels have a few supporting rods close to the tip. In the original description nothing is said about the color, but the present specimen is a light brown with the pedicels whitish. The calcareous ring does not have such long posterior projections as are indicated in the figure given by Joshua and Creed, but there would be some diversity in this respect of course. There is no label with this paratype to indicate where it was taken but since it was secured by Dr. Verco, it is probably from St. Vincent Gulf.

LIPOTRAPEZA VESTIENS

Phyllophorus vestiens JOSHUA, 1914. Proc. Roy. Soc. Vict., **27**, p. 5.

Joshua's account of this species is very satisfactory and I find nothing to add to it from my own observations other than concerning the size and calcareous particles. Many of the specimens at hand are much larger than those examined by Joshua, the largest being 240 mm. long by 30 mm. in diameter; the smallest is 50 x 8 mm. Regardless of size there is remarkable agreement in the calcareous ring and in the deposits in the pedicels and tentacles. There is, however, some diversity in the calcareous matter around the anus. Some of the smaller specimens show numerous miliary rosettes and minute rods such as occur in *ventripes* and in several cases there is evidence of microscopic anal teeth, too small to note except with high magnification. In two small specimens, tables were present, much like those found in such species of Phyllophorus as *cebuensis* and *trapezus*. Evidently the anal region retains youthful characters and indications of the phylogenetic history of Lipotrapeza persist there until full maturity is reached. In color all the specimens are light brown, of some shade, or else are more or less bleached.

The material before me, excepting one specimen from Tasmania, was loaned or given me by Mr. L. Glauert of the Western Australian Museum or by Professor E. W. Bennett of the University of Western Australia. Mr. Glauert's specimens were collected at Cottesloe Beach, where they were washed up during a storm in July 1926; they are accordingly in poor condition but there is no mistaking their identity. Mr. Bennett's specimens were collected in extreme southwestern Australia near Cape Naturaliste. Owing to the difficulty of procuring preservatives, some of this material is not in very good condition but all of it is identifiable. In all there are 37 specimens from the following places.

Western Australia: Cottesloe Beach, beach drift, July 1926. 11 specimens in poor condition.
Bunker's Bay, "under large stones on well sheltered patch of sand, also in sand and grit in rock pools," at very low tide, January 1930. 22 specimens, in fair condition.
Ellen Brook Beach, January 1930. 1 rather poor specimen.
Cape Leeuwin, January 20, 1930. 2 specimens, fair.
Tasmania: Northwest coast, Wynyard, low tide. T. T. Flynn leg. et don. 1 good specimen.

Urodemas

Selenka, 1867. Zeits. f. w. Zool., **17**, p. 352.

This genus was proposed by Selenka for a dendrochirote holothurian with 20 tentacles from Port Jackson, but subsequent writers did not accept it. Semper (1868) made it a synonym of Orcula, a decision accepted by Bell (1884), but Lampert (1885), Theél (1886) and Ludwig (1892) all agreed in placing it in the synonymy of Phyllophorus. Our knowledge of the latter genus and the number of species now referred to it, warrant, however, a more careful delimitation of the group. There can be no doubt that the Australian form described by Selenka stands apart from the typical species of Phyllophorus (*urna*, *pellucidus*, *communis*), and the generic name Urodemas may well be revived for it, as Heding (1934, p. 23) has recently suggested. The diagnosis of the genus is as follows: Dendrochirote holothurians with 20 tentacles, numerous pedicels irregularly scattered over the body, a very high, more or less cartilaginous, calcareous ring, numerous polian vessels and madreporic canals, and the calcareous particles in the skin, mostly rods, with or without either perforations or spinous projections (often perforations at one end and spinous projections at the other); if table-like particles occur also, they are coarse and irregular or they have peculiar high spires and very small disks with few perforations; but more elaborate tables may occur in the introvert or tentacles.

The genus was monotypic when established and the type-species is *U. perspicillum* from Port Jackson. In 1884, Bell records "*Orcula perspicillum*" from "Port Denison and Port Stephens," presumably on the Queensland coast, but not a word of information is given as to the size or appearance of the specimens or why they were regarded as *perspicillum*. No other records of the species have been published so far as I know, except Whitelegge's (1889) interesting note, asserting that the species is a Phyllophorus and not an Orcula, and that he has seen specimens from off Shark Point, Port Jackson. In the "Challenger" Report Théel (1886, p. 97) describes two strongly contracted holothurians from Port Jackson, as a new species of Phyllophorus, which he calls *incompertus*, obviously because he was dubious as to its validity. He states very definitely that he thinks it identical with Selenka's species, but there are small tables and other particles present in the skin, which Selenka does not mention. Heding (1934, p. 23) has already asserted the identity of the two forms and my observations on the material in hand support his position. But I cannot agree with him (l.c.) that the Urodemas from Hong Kong which he identifies as *perspicillum* is really that species, for his excellent figures of the calcareous particles are strikingly different from the figures given by Selenka and Théel in describing the Port Jackson form. Fortunately there is a specimen from Hong Kong in the M. C. Z. collection of the form discussed by Heding which enables me to satisfy myself that the Chinese species is quite distinct from the Australian. Using our specimen for a holotype, I therefore name and diagnose the species in this report (see p. 500).

Besides these two forms, there are two other holothurians which may properly be placed in Urodemas. One of these was described by Ludwig (1874) under the name *Thyonidium schmeltzii;* he had five specimens from Bowen (Queensland) and one from "Golf St. Vincent." The other was named by Sluiter (1914) *Phyllophorus hamatus*, and was based on five specimens from the Java Sea. Curiously enough, Sluiter makes no reference to Ludwig's species, though the resemblances are very striking. Fortunately both species were taken by me at Broome and I am therefore able to give some further information about them. The differences between the four species of Urodemas are most easily emphasized by means of an artificial key.

Key to the Species of Urodemas

A. Calcareous particles in the form of short irregular rods, which may be perforated at one end, smooth and pointed at the other, or coarse and spinous at one end or both; tables of some sort may be present in pedicels, introvert or tentacles, especially in young individuals.

Calcareous rods minute, smooth, perforate at one end (or both); tables if present, of delicate structure. . . . . *perspicillum*

Calcareous rods, coarse, spinuous at one end or both; tables if present low and coarse. . . . . *crassum*

A¹. Calcareous particles elongated into rods (or high-spired slender tables) perforated at the inner end, terminating distally in a spinous knob.

Spinous rods much alike, smaller proximally than distally, resembling a club with a spiked head; they lie parallel and crowded in the skin; no peculiar hook-bearing plates in pedicels . . . . *schmeltzii*

Spinous rods more table-like, the proximal end like a disk with four perforations; the distal end shows much diversity but is frequently like a spiked club; pedicels with peculiar hook-bearing plates . . . . *hamatum*

Urodemas perspicillum

Urodemus perspicillum Selenka, 1867. Zeit. f. wiss. Zool., **17**, p. 352.

Orcula perspicillum Bell, 1884. Proc. Linn, Soc. N.S.W., **9**, p. 506.

Phyllophorus perspicillum Lampert, 1885, Die Seewalzen, p. 178.

Phyllophorus incompertus Théel, 1886. "Challenger" Holos., p. 97.

Phyllophorus perspicillum Théel, 1886. "Challenger" Holos., p. 150.

Phyllophorus perspicillum Whitelegge, 1889. Proc. Roy. Soc. N.S.W., **23**, p. 206.

Phyllophorus perspicillum Ludwig, 1892. Die Seewalzen, p. 347.

Non *Phyllophorus* (*Urodemas*) *perspicillum* Heding, 1934. Hong Kong Nat., **5**, no. 3, Supplement, p. 22.

Of this species, there is a single small specimen, 35 mm. long by 25 mm. in diameter, in the collection before me. It was loaned by the Australian Museum and is, I believe, the smallest specimen as yet recorded; it was taken in Port Jackson, near Sow and Pigs Reef, in 6–8 fms. The calcareous particles in the skin resemble those of *incompertus* as figured by Théel, but not all of the forms illustrated by him were detected by me. In the M. C. Z. collection there are 3 very large specimens of *perspicillum*, taken in the eastern channel, Port Jackson, Jan. 3, 1930, by Captain Comtesse of the dredging vessel "Triton." They measure 110 x 50, 125 x 55 and 150 x 65 mm.; the smallest is fully contracted, the others show the tentacles well. Owing to their large size and to the habit of contracting the oral end and swelling the body greatly, these holothurians are known to the dredgers as "foot-balls." It is evident that in young individuals the calcareous particles are much more diversified than in the adults; the short, rather fragmentary perforated rods figured by Selenka are fairly abundant in the large specimens but the tables and other diversified particles figured by Théel have more or less disappeared. Except for Bell's records from the Queensland coast, which are not beyond question, *perspicillum* has not been reported from anywhere outside of Port Jackson.

Urodemas crassum[1] sp. nov.

Length 140 mm.; diameter about 55 mm. Tentacles, calcareous ring and inner organization as in *perspicillum*. Calcareous particles in the body wall consist chiefly of short, stout rods with coarse, pointed projections at the ends; these rods may be wide enough to be called plates and are then often perforated; in some cases these perforated plates have an imperfect low spire and may be called tables; in the tentacles, tables with a more normal and taller spire may be found. Heding has given (1934, p. 22) excellent sketches of these deposits, showing their diversity; in the holotype, rods like Heding's figures 1, 2, 6, 7, 8 and 9 make up the great bulk of the deposits. Rosettes occur in the introvert and at the base of the tentacles.

Color white, but there is no doubt this is the result of bleaching. Heding speaks of a "dorsal and darker side" but makes no further reference to the color. Probably the color in life is brown, much as in *perspicillum* but the bleached condition of the holotype suggests the possibility of a lighter brown or a reddish tint; the red shades of holothurians seem to bleach out rapidly as a rule.

Holotype, M. C. Z. no. 379, from Hong Kong; taken by Captain W. H. A. Putnam in 1861. Apparently this specimen was not sent to Selenka with the bulk of the M. C. Z. holothurians. But this is easily explained, for much of Captain Putnam's valuable material, collected at Hong Kong and elsewhere, for the M. C. Z., could not be sorted out and incorporated in the study collections for years after it was received.

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[1] *crassus* = coarse, stout, in reference to the calcareous particles in the skin as compared with those of *perspicillum*.

Urodemas schmeltzii

Thyonidium Schmeltzii Ludwig, 1874. Arb. Zool.-Zoot. Inst. Würzburg, **2**, p. 94.

Phyllophorus hamatus Ekman, 1918. K. Svens. Vet. Akad. Handl., **58**, no. 6, p. 54 (non Sluiter, 1914).

This is a common holothurian at Broome and along the northwestern coast of Australia, and is not rare apparently on the coast of Queensland, although it was not represented in the collections of the Great Barrier Reef Expedition, 1928–29. We did not find it at Darwin, but I have little doubt that it occurs in that region. Ludwig's statement that one of his six specimens was from "Golf St. Vincent" is perplexing. It is highly improbable that this can be St. Vincent Gulf of South Australia, especially since neither Joshua nor any other collector has found the species on the southern coast of the continent. Probably the label was erroneous.

Few holothurians are more easily recognized by their spicules than is *schmeltzii*. It differs so much from typical Phyllophorus in this respect that a new genus seemed desirable for it. But study of its other characters soon revealed the fact that it may well be placed in Urodemas, as it agrees with the type-species *perspicillum* in all essentials, though differing so conspicuously in the details of he calcareous rods in the skin. In very young specimens of *schmeltzii* the base of the rods is somewhat more expanded than in adults; apparently this may be interpreted as a growth stage showing that the rods have been derived from such tables as occur in *hamatum*.

The collections at hand contain 41 specimens of *schmeltzii*, ranging in size from 18 x 7 mm. to 85 x 30. There is no little diversity of coloration, apparently not associated with age, size or locality; individuals of the same size from a single locality may differ quite markedly. My field notes say: "Color may be yellow, flesh-red, brown, olive or blackish." In preserved material the ground color ranges from light brown to a deep purplish-brown, almost black in extreme cases. Often examination with a lens shows that a dark ground color may be due to a fine mottling with dark on a really light basis. In some individuals the dorsal side is distinctly darker than the ventral, but this is not usual. The tentacles are darker than the ground color and often look quite black, though the stalks are usually lighter than the small branches. The pedicels which are relatively large and numerous are light colored, often pale yellowish or nearly white, but the terminal disk is brown (more or less deep) in sharp contrast. When partially retracted, the pedicels thus give the animal a spotted appearance, but often they are so fully retracted into the thick body wall that they do not affect the coloration. When young, *schmeltzii* lives under rocks and among corals near low tide mark, and adults are found in the same habitat occasionally, but the latter are sometimes dredged in 5–7 fms., where they apparently live more exposed on open bottom.

The material in hand is from the following places:

Queensland: Port Curtis, Rat Island, shore. Ward and Boardman leg. 5 specimens. Loan from Australian Museum.
Western Australia: Augustus Island, Beresford E. Bardwell leg., 1933. 4 specimens.
Broome, 1929. 8 specimens.
Broome, 1932. 9 specimens.
False Cape Bossut, 1929. 15 specimens.

URODEMAS HAMATUM

Phyllophorus hamatus SLUITER, 1914. Contr. Fauna Ind. Neerl., **1**, p. 17. (non Ekman, 1918).

It is a curious fact that Ekman in his careful study of a very young Phyllophorus from the northwestern coast of Australia never even considered *schmeltzii* but referred it with some doubt to this species of Sluiter's. His excellent description and figures show conclusively that he had in hand a very young specimen of Ludwig's species. Having reached this conclusion I was much surprised to find among my holothurians from Broome, a little individual, only 15 mm. long by 5 in diameter, which possesses spicules so much like those of Sluiter's species that I think it must be referred to *hamatum*. In two particulars, however, it is markedly different and if these differences prove to be real and constant, the Australian form should be distinguished as a separate species. In the first place, the pedicels are not, as Sluiter says, "ziemlich gleichmassig uber den Korper verteilt;" on the contrary they are numerous and rather crowded on the lower side, few and well-spaced above; the contrast between the dorsal and ventral sides is thus rather striking. However, as the specimen from Broome is much smaller than the smallest one seen by Sluiter, this might be interpreted as an age difference. In the second place a large part of the tables in the body wall have the spires expanded, flattened, perforated and ending in two points, quite unlike anything mentioned or figured by Sluiter. It is not impossible, however, that these curious tables are also a growth stage, lacking in adults. One other difference may be mentioned; the extraordinary hooked plates in the pedicels are stouter, with shorter, heavier, more erect hooks, than Sluiter's figure indicates. His figures, however, are obviously not drawn with a *camera lucida* but are free-hand sketches, so that this difference may be unreal. Until further material is secured it seems best to refer this little Urodemas from Broome (dredged in 1932) to Sluiter's species from the Java Sea.

PSOLIDIUM GRANULIFERUM[1] sp. nov.

Length 15 mm., width 7, height, 5; sole flat, sharply defined, 13.5 mm. long by 6 wide. Mouth and anus both distinctly dorsal in position and not elevated. Excepting the sole, which is covered by a moderately thick, somewhat wrinkled skin, the animal is encased in a firm coat of scales, which overlap dorsad as usual; along the sides, several series close to the margin are very small but just above them are the largest scales, 1.25–1.5 mm. long and about 1 mm. high; on the back the scales are smaller again; there are about 25 series from one sole margin to the other across the back; between mouth and anus, around which openings the scales are very small and rounded, one may count about 15 scales but they are very irregular in size and form and their outlines are indistinct. All the scales have a rough, shagreen-like surface and (excepting the smallest ones) bear relatively coarse granules which are as a rule more or less spherical; there may be as many as 6–8 on a scale and in such cases they are rather uniformly distributed over the scale, but usually there are not so many granules and they are located mostly near the upper margin of the scale. Some of the largest granule-like objects on the dorsal surface appear to be cylindrical and concave at the top like contracted pedicels and whiter than the others. Examination under the microscope reveals a coarse calcareous network in them and fails to show any satisfactory indication of a perforation in the scale beneath. It is probable that these are rudimentary pedicels, and warrant placing the species in Psolidium.

Even on the sole, the pedicels are small and much reduced. A double series around the margin is fairly well developed, the two series being well separated from each other; the outer one is made up of smaller pedicels but is apparently more complete. At first sight there seems to be no median series of pedicels on the sole but more careful examination with a lens reveals several pedicels at each end, the anterior ones being quite well-formed, and between the two groups are here and there very indistinct pits which seem to be contracted pedicels of very small size. As I have little doubt of the generic position of this holothurian, it has not seemed necessary to cut it open to examine the contracted tentacles or the internal anatomy.

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[1] *granuliferus* = in reference to the granules borne on the dorsal scales.

Calcareous particles in the dorsal epidermis are not much in evidence, those noted seeming to be fragments of the granules. In the sole, the particles are abundant and characteristic; they are perforated plates (fig. 49) of varied size (70–400μ) commonly with more or less numerous knobs around the margin and scattered over the surface; in their simplest form these plates are flat and have a few (3–6) rather large nearly circular perforations and no knobs, but as growth continues the perforations become more numerous, the knobs develop, spread and coalesce, and gradually a coarse, lenticular scale of considerable thickness at the center is formed. These knobbed plates are numerous but by no means crowded and do not form layers in the sole, which remains soft and flexible.

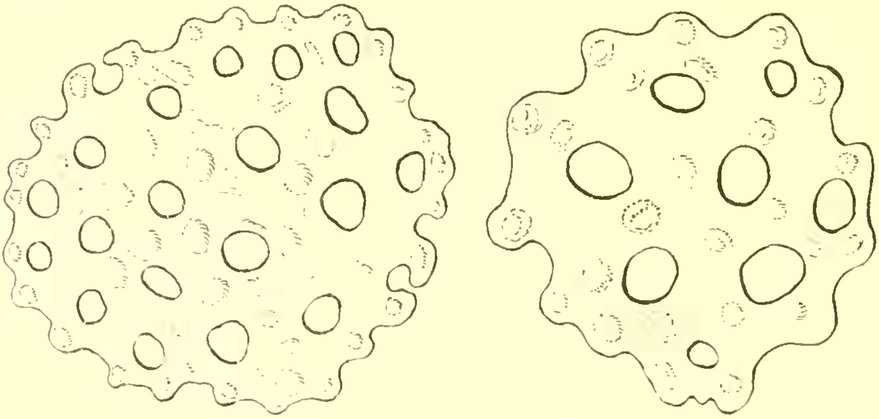

Fig. 49. Psolidium granuliferum. Perforated plates from sole. x 425.

Color light gray, darkest on the middle of back and along sides; around introvert and anus the color is dirty whitish but shades into the gray; the sole is distinctly white.

Holotype, M. C. Z. No. 1666, from Koombana Bay, Bunbury, Western Australia, 5–8 fms., October 26, 1929.

This unique specimen was listed in my field notes merely as "1 small, gray Psolus-like species." It is evidently quite distinct from any known member of the group, particularly from any known Australian form. It may be well to add that it is not in the least like *Psolus imperfectus* H. L. C. from South Africa.

Psolidium nigrescens[1] sp. nov.

Length 32 mm., greatest width, 12 mm., height 11 mm.; sole well-defined with distinct but not sharp margins, about 20 mm. long by 7 mm. wide anteriorly and 11 mm. posteriorly; in the present contracted condition, the anterior end of the sole is only about 3 mm. from the anterior end of the animal while the posterior margin of the sole is almost 9 mm. in front of the slightly projecting anal region. All of the body surface except the sole is encased in a firm coat of overlapping scales; near the mouth and the anus these scales are very small as they are also close to the margin of the sole, but near the middle of the body they are much larger and may exceed two mm. in width by over a millimeter in height; they overlap dorsad nearly to the mid-dorsal area where there is little or no overlapping and the scales are smaller, very small near both the introvert and anus; there are more than 20 scales in a longitudinal series between those two points, and there are no large plates or scales at either end of the animal. The sole is covered by a thick, firm skin, more or less wrinkled longitudinally in the preserved specimen; at first sight it looks as tho covered by longitudinal series of small overlapping scales. Pedicels numerous all over back and sides, rather small, with no indication of any longitudinal or serial arrangement even near the mouth or the anus; on the sole, the pedicels are larger and are crowded in the usual three longitudinal areas; each lateral area is made up of four (or five) series (150–175 pedicels) while the median area has four series at each end but near the middle there are only three, or even two (125–140 pedicels). Tentacles 10, the two ventral much smaller than the others. Calcareous ring stout, with no marked difference between the radial and interradial pieces; each has a deep notch in the posterior margin and a conspicuous anterior prolongation; these features are somewhat more pronounced in the radial pieces. There is one rather large madreporic body but the polian vessel is not evident. The posterior part of the intestine lies in the right ventral interambulacrum.

Calcareous particles in the dorsal epidermis, not abundant, but very distinctive; there are rosettes (fig. 50 a) of various degrees of complexity, ranging from slender, elongated, with few branches, to short, thick, densely branched particles, whose origin is however still indicated; accompanying the rosettes are fairly numerous triradiate particles (fig. 50 b), the arms of which bend upward so that the spicule appears like the three-ribbed support for a cup. In the sole the spicules are very numerous in many layers; in the outermost are curious triradiate spicules like those of the dorsal surface but somewhat larger and occasionally with four arms instead of three; with these are perforated concave or saucer-shaped plates of characteristic form; the smaller ones (fig. 50 c) about 75μ in diameter, are quite symmetrical with 4 circular perforations and about 8 knobs on the margin; but most of the plates are much larger (fig. 50 d), up to 250–300μ, much less symmetrical and with more perforations and knobs; the inner layer of calcareous material in the sole is almost wholly of these asymmetrical plates. Pedicels with a few wide perforated supporting rods and greatly reduced end plates; the latter are naturally more evident in the better developed ventral pedicels. Tentacles crowded with rosettes and supporting rods; the latter range from coarse, wide ones with many perforations, in the tentacle stalk, to very slender, minute rods with enlarged ends in the terminal branches.

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[1] *nigrescens* = growing black, approaching black, in reference to the unusual color.

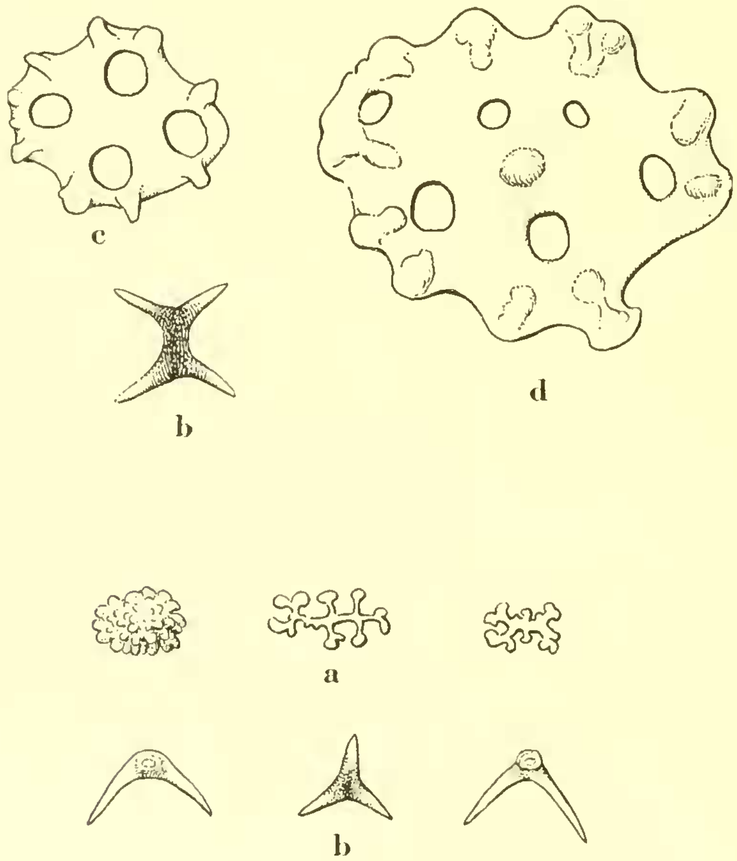

Fig. 50. Psolidium nigrescens.

Color, very dark gray, quite blackish near introvert and anus; dorsal pedicels pale cream color, but their small size prevents their modifying the dark dorsal surface very perceptibly; sole dirty whitish with brownish cast, the pedicels more nearly cream-white. Tentacles variegated whitish and dark gray. The color is apparently little affected by alcohol.

Holotype, M. C. Z. No. 1665, from shallow water, Gunnamatta Bay, Port Hacking, New South Wales, November 26, 1929.

This unique holothurian is evidently quite different from any species of Psolidium previously described. The dark color led me to think I had in hand a large specimen of *Psolidiella nigra* Mortensen but it is quite evident that the Australian and New Zealand species are not even congeneric. The calcareous particles of the Australian form are highly distinctive but aside from them, the unusual color, the body form, the numerous scales and pedicels of the dorsal side, the sharply defined sole with unusually numerous pedicels combine to set *nigrescens* apart as an easily recognized member of the genus Psolidium. Whitelegge (1889) records a Psolus as taken off Balls Head, Port Jackson, by Dr. Ramsay but unless the specimen is still extant, we can only speculate as to whether it may have been this Psolidium which would certainly have been called Psolus fifty years ago.

Psolus minutus[1] sp. nov.

Length 7 mm., width 3, height 2.5; sole evident, but not sharply defined, the margins being rounded, about 6 mm. by rather less than 3. Mouth and anus distinctly dorsal in position and not elevated. Excepting the sole, which is covered by a thin skin, the animal is encased in a firm coat of scales of small size and irregular arrangement; in general it may be said, they are smallest near anus and introvert and around margin, and largest on the sides; there are no conspicuous valve-like scales at either end of the animal; on the contrary, around the introvert the alternate scales are narrow and pointed. There are approximately 13–15 series of scales from margin to margin across the back, while between mouth and anus there are about 10 scales. Some of the larger scales bear a very few coarse granules but commonly there is not more than one to a scale. No pedicels on dorsal surface or sides; ventrally, there are double series of pedicels all around the sole and down the midventral ambulacrum, but the pedicels are small and much contracted. Tentacles 10, the 2 ventral markedly smaller. Calcareous ring (fig. 51) quite stout, both radial and interradial pieces about half a millimeter high each with a large anterior prolongation, pointed in the interradials, wider and rounded in the radials; the posterior margin of each piece is markedly concave, if not actually notched. Neither polian vessel nor madreporite was detected in the specimen dissected.

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[1] *minutus* = very small, in reference to its being apparently the smallest species in the genus.

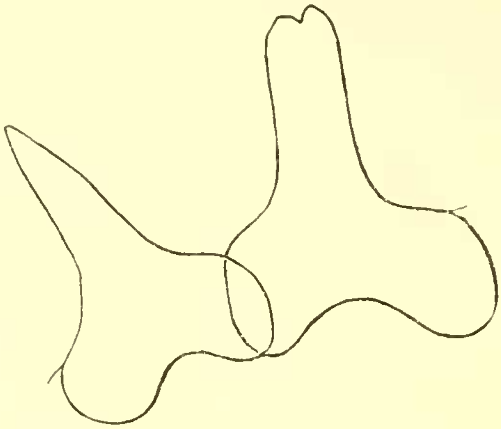

Fig. 51. Psolus minutus. x 90. Interradial and radial pieces of calcareous ring.

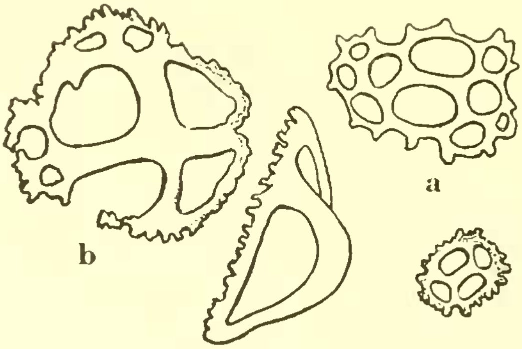

Fig. 52. Psolus minutus. Calcareous particles. x 425. a. From back. b. From sole.

Calcareous particles in the dorsal epidermis abundant; the fundamental form is a plate (fig. 52 a) with 4 perforations, 2 smaller ones, nearly circular, and 2 larger ones, elongated elliptical, lying side by side, between the smaller ones; on the one hand these develop into delicate little, deeply concave "baskets" with the margin provided with many projecting knobs, while on the other hand they become rather irregular flat plates with 10–12 perforations (or more) and rounded projecting points on the margin. In the sole both these types of spicule are present and in addition a very much larger and coarser "basket" (fig. 52 b) occurs rather sparingly, while many of the perforated plates are also larger and coarser.

Color, pure white both in life and in alcohol; tentacles with a distinctly yellowish tint.

Holotype, M. C. Z. no. 1667, from under surface of a rock fragment near low water mark at Neds Beach, Lord Howe Island, April, 1932. There are 30 paratypes from the same place.

This little Psolus is not rare at Neds Beach but owing to its small size and secretive habit it is not easily found. The largest specimens were less than 10 mm. long in life and the width is about half the length; whether they are mature or not I am not sure. When first detected the delicate appearance and pure white color led to the supposition that the animal was a nudibranch but examination with a lens soon revealed its true nature. When fully expanded, the tentacles sometimes appear to be anterior rather than dorsal in position but it seems to me that this may be only when the animal is moving forward. Many of the paratypes have the margin of the sole much more sharply defined than it is in the holotype, but in such cases the animal was probably clinging tightly to some object when killed. In some individuals the width nearly equals the length, the sole being almost circular but this is probably due to death occurring when the animal was entirely detached and not fully relaxed.

The relationships of this very small Psolus are not easy to determine. Dr. Deichmann has called my attention to the fact that the calcareous spicules resemble those in some species of Psolidium, but the Lord Howe species is so clearly a Psolus, this cannot lead to any confusion, unless indeed further collecting demonstrates that these specimens upon which *minutus* is based are very young and do not yet reveal their generic characters.

PSOLUS SPINULIFERUS[1] sp. nov.

Length 13 mm., width and height about 3.5 mm. each; it is obvious however that the specimen is much compressed and the probable normal measurements would be about 12 x 7 x 3 mm. In life, the specimen was 20 mm. long but its width was not recorded. Mouth and anus distinctly dorsal in position and not elevated. Excepting the sole, which is sharply defined and covers the whole lower surface, the animal is encased in a coat of scales of small size and irregular arrangement; in general it may be said they are smallest near anus and introvert and around margin, and largest on the sides; there are no conspicuous valve-like scales at either end of the animal. There are about 15 series of scales from margin to margin across the back and about 10 between mouth and anus. Scales smooth but each one (approximately), excepting the very small ones, bears a low conical tubercle or spinule; some of the larger scales may bear two such spinules; these are very different in form and appearance from the rounded granules of the two preceding species, and give a distinctive roughness to the body surface.

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[1] *spinuliferus* = bearing little spines, in reference to the spinelets on the dorsal scales.

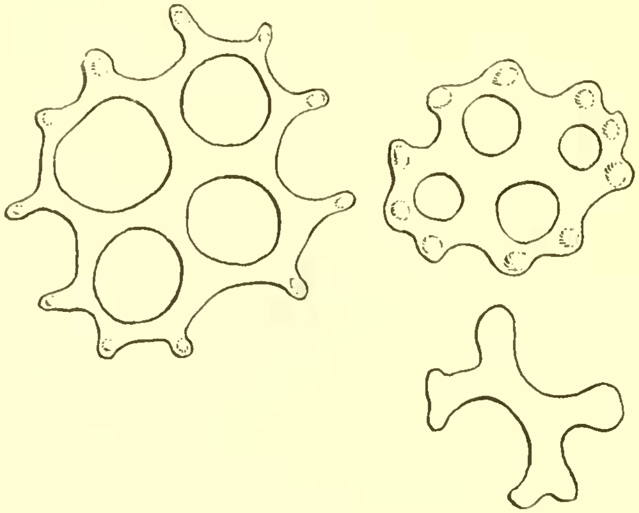

Fig. 53. Psolus spinuliferus. Calcareous plates from sole. x 425.

No pedicels on dorsal surface or sides but on the sole there is a well-marked double series of fair-sized pedicels and a definite series is also present on the mid-ambulacrum; this series is distinctly double at and near each end but in the middle only a single rather irregular series of pedicels is present. As there is no reason to doubt the generic position of this species, it has not seemed necessary to cut it open to examine the contracted tentacles or the internal anatomy.

Calcareous particles seem to be wanting in the epidermis of the dorsal surface; nothing was found but obvious fragments of the scales. In the sole however there are numerous but by no means crowded plates (fig. 53) of the *squamatus* type; these occur in all stages of development from short rods with bifurcated ends to symmetrical plates something more than 100μ in length with 4 large perforations and 10 -- 12 projections of slight or considerable length, each of which carries a more or less obvious elevation or tubercle. No plates were seen with more than 4 completed perforations, though the proximal portion of 1–4 more were frequently indicated.

Color yellowish-white, most yellowish at the anus and introvert, most nearly white on the sole.

Holotype, M. C. Z. no. 1669, from 10–12 fms., off 80-mile Beach, Northwestern Australia, June 9, 1932.

This unique specimen is the only psolid taken during the many weeks of intensive collecting in the vicinity of Broome during 1929 and 1932. The entry in my field-book reads: "Pure translucent white, 20 mm. long, on outside of pearl shell. A typical Psulus, I guess." It is interesting to find on critical study that this species from northwestern Australia is apparently nearer to the long known European species *squamatus* than to any of its congeners from Australasia. And this takes on some significance when we recall that *squamatus* occurs in Japanese waters. It is doubtful whether *Ps. boholensis*, Semper (and its variety, *pandanensis*) from the Philippine Islands, are nearly related; the statement that they have the body Ascidia-shaped certainly indicates a complete lack of any superficial resemblance. The symmetrical plates in the sole resemble very obviously those of *Ps. parmalus* Sluiter from "Siboga" Station 259, for sketches of which I am indebted to Dr. Deichmann. In other particulars however the differences between the two species are too great to be ignored.

HOLOTHURIIDAE

Stichopus mollis

Holothuria mollis Hutton, 1872. Cat. Echinoderm. N.Z., p. 15.
Stichopus mollis Dendy, 1897. Jour. Linn. Soc.: Zool., **26**, p. 46.

One of the most interesting to me of the echinoderms dredged at Hobart, Tasmania, November 15, 1929, was this fine holothurian, originally described from New Zealand. It happened that the first of the several specimens taken was the handsomely colored form described in my field notes as having the body surface "light and dark gray, each dorsal papilla circularly vermiculated with fine dark lines." These fine dark lines also run both longitudinally and transversely on the back in an irregular pattern. Such a coloration is very striking and makes the animals, as my notes say, "quite a handsome Stichopus." While this color pattern was marked in some individuals, it was not present in all. Some of those dredged were brown rather than gray and showed the dark lines little or not at all. They were all adults, 160–250 mm. long, and were taken on the west side of the estuary in 2–3 fms. Mortensen (1925, p. 329) says that the New Zealand specimens of *mollis* are "dark brown or black" but makes no reference to size. Dendy and Hindle (1907, p. 96) say their specimens were 70–134 mm. long and in color, "very dark brown" or brown with "dirty-white markings" or "almost white." Joshua (1914, p. 2) says that *mollis* "is common in Port Phillip Bay and at numerous localities on the coast" (of Victoria, presumably) but he says nothing of the color or size. In the M. C. Z. collection are 21 specimens in rather poor condition dredged at Westernport, Victoria, in 1–5 fms. by Mr. J. Gabriel, in 1911. They measure 35–145 mm. in length, the same size as New Zealand specimens but somewhat smaller than those from Hobart which are apparently the largest yet recorded. In coloration these Victorian *mollis* show great diversity; many show the vermiculations described above as beautifying some of the Tasmanian specimens, but others are without them; several are light-colored and one half-grown individual is pale gray, the ventral surface and pedicels nearly white. Erwe (1913, p. 387) reports 4 specimens from near Albany, W. A., as having the back brown, the ventral surface brown-black, the pedicels with white tips in pretty contrast. No specimens that I have seen give any indication of such a coloration.

The 4 preserved specimens at hand from Hobart, contracted to 140–175 mm., are now colored as follows: 1 is light grayish, and 1 is light brown, with dark brown lines, crisscrossing on back and encircling the papillae; 1 is variegated dark brown and whitish with tips of papillae very dark; 1 is brownish-white (or dirty cream-color) variegated with brown and has most of the papillae with brown tips. On the whole these four individuals reveal fairly well what their coloration was in life.

Erwe (1913, p. 388) records a specimen of *Stichopus simulans* Dendy and Hindle (unfortunately printed "*simultans*") from Rottnest Island, W. A. Mortensen (1925, p. 328) has shown that *simulans* and *mollis* are really identical, hence we may consider the geographical range of *mollis* as extending from New Zealand along the southern and southwestern coasts of Australia as far as Rottnest Island.

STICHOPUS VARIEGATUS

SEMPER, 1868. Holothurien, p. 73.

There are 14 specimens at hand which I am referring to this common Stichopus and owing to their diversity they may best be discussed in geographical sequence.

Two are from Lord Howe Island, the southernmost point yet known for the species. One taken at Neds Beach, April 20, 1932, is now a somewhat purplish-brown and is 155 mm. long by 55 mm. wide (artificially flattened) but in life it was 250 mm. long, "deep flesh color with the huge lateral tubercles nearly white-tipped." The other taken at Neds Beach, April 6, 1932, was much bigger, measuring when living about 350 mm. long, 60 mm. wide and 50 mm. high; even now it is 250 x 45 mm. The color in life was "light brown with a pinkish tinge (many big papillae lighter still) variegated with lighter and darker shades; many big papillae lighter; lower surface crowded with pedicels, dull pinkish with a lavender cast; tentacles nearly white. Not handsome." At present this large specimen is dull brown, variegated in various shades; the tentacle branches are dark but the stalks are dull whitish. Both the Lord Howe specimens were taken on patches of sand, among living corals, and appear to be typical examples of *variegatus*.

There are 2 specimens from Norwest Islet, Capricorn group, Queensland, taken in July 1929 by Boardman and Ward of the Australian Museum; the larger, 150 x 50 mm. is dull brown while the smaller, 110 x 35 mm., is a darker blackish-brown. These also seem to be typical *variegatus*.

No Stichopus was found at Darwin but there are 2 specimens from Augustus Island, Northwestern Australia, taken in October, 1933, by Captain Bardwell. They are small individuals, only 75 x 25 mm. and 100 x 40 but in form and general appearance, and in the calcareous deposits they agree well with young *variegatus*. The general color is indefinitely variegated light brown and neither pedicels nor tips of papillae are noticeably different.

Seven specimens of Stichopus from Broome cannot be distinguished by their calcareous deposits from typical *variegatus* but nevertheless appear to be a different form; and if *variegatus* were not known from west of Cape Leveque, I should not hesitate to recognize these small western specimens by a varietal name. They are distinguished by their small size (80–140 mm.) and the dark tips to the pedicels and papillae, which stand out in sharp contrast to the lighter brown of the body wall. Since Erwe (1913, p. 386) however records a specimen of *variegatus* definitely from Shark Bay, 2 others from Western Australia and 1 from southwestern Australia, and particularly states that the pedicels and tips of the papillae were not essentially different from the general coloration, it seems better not to give a varietal name to the specimens from Broome. It may be mentioned however that Erwe's specimens were also small, only 80–90 mm. long.

A single Stichopus (M. C. Z. no. 1559) dredged by Mr. Livingstone September 20, 1929, "about 20 miles south from Cape Jaubert, 5 miles from shore, 5–8 fms., muddy sand and weed," has been a source of much perplexity. In life, the coloration, according to Livingstone's field notes, was "almost equal sized patches of whitish-gray, wisteria mauve and pale ochre yellow; ventral side, semitransparent grey-white." The preserved specimen, which measures about 135 x 30 mm. is dirty whitish with some irregular, more or less faint, blotches of yellowish-brown dorsally. The pedicels are relatively few and are almost wanting in the mid-ventral area; their tips are quite brown in sharp contrast to the almost white ventral surface. When I first examined this specimen, I had no doubt that it was a new species of Stichopus but I can find no distinctive characteristic in the calcareous spicules. They seem to be exactly like those of *variegatus*. Under the circumstances therefore, until more material is available, it seems best to designate this rather striking Stichopus as simply a variety of *variegatus* which we may appropriately call *pallidus*.

Stichopus ellipes[1] sp. nov.

Length 163 mm.; width in its present much flattened condition 27–36 mm.; in life, this individual was probably about 190 mm. long and 35 mm. in diameter. Contrast between dorsal and ventral surfaces, very marked, but the scattered papillae of the dorsal side are small and scattered so that no definite longitudinal series are now visible and there are no tubercles or conspicuous papillae along the margin of the ventral surface. Pedicels rather small, fairly abundant on the ventral surface in three irregular and ill-defined longitudinal series; around the oral area there is a very definite close-set circle of papillae which must have formed a rather conspicuous collar in life. Tentacles 20, of moderate size and normal appearance. Calcareous ring not very stout, the anterior prolongations short and the posterior marginal concavities shallow. Genital organs in two distinct tufts of about equal size, one on each side of the dorsal mesentery. Polian vessel and madreporic body, each single.

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[1] ἐλλιπής = *wanting, deficient*, in reference to the absence of rosettes and C-shaped particles.

Calcareous particles, tables alone except for the usual supporting rods and terminal plates in pedicels and papillae. No C-shaped bodies or rosettes could be found. Tables (fig. 54) very abundant, forming a close body covering, rather large when fully developed, the disks 80–85μ in diameter and the height of the spire about two-thirds as much. Disks with 4 large central perforations, surrounded by about a dozen smaller ones in a fairly regular series, and a number of still smaller ones in an incomplete and irregular distal series. Seen from above, the spire, made up of 4 vertical rods, is squarish and at the summit has many teeth irregularly disposed but chiefly at the corners; from the side, it is evident that the tip of the spire is commonly not abruptly truncate but is more or less rounded-conical. These fully developed tables are very distinctive but of course they are outnumbered by the many less completely developed ones, in which the disks are smaller and have fewer perforations and the spires are lower and more abruptly truncate.

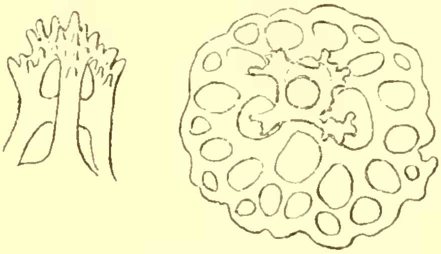

Fig. 54. Stichopus ellipes. Table. x 425.

Color gray with a brownish cast, with faint blotches of a darker gray all over the back and sides; these are usually associated with the papillae; in addition there are hundreds of minute dark, almost black dots irregularly scattered over the animal but chiefly dorsally, those on the ventral surface, which is somewhat darker than the dorsal, being few and rather indistinct; pedicels dirty whitish the disks light brown; tentacles very light brown, probably whitish or pale yellow in life.

Holotype, M. C. Z. no. 1553.

The unique specimen upon which this Stichopus is based was taken at Broome in 1929. Unfortunately it lacks any field label or number so that there are no data available to throw light on either its habitat or habits. Since it was not met with in June 1932 when the collecting was almost wholly by dredging, of which we did relatively little in 1929, it seems probable that this Stichopus was found along shore near low water mark.

LABIDODEMAS SEMPERIANUM

SELENKA, 1867. Zeits. f. w. Zool. **17**, p. 309.

There is a single specimen of this species in the collection at hand. It is about 85 mm. long but owing to unequal contraction it is only 12 mm. in diameter at the anterior end while posteriorly it is 28 mm. The general color is dull gray but the strongly contracted anterior end is almost black. The calcareous tables are distinctive, the spires terminating in long nearly horizontal points, often (but not usually) 5, and frequently bifurcate at tip. Few are however as symmetrical as Selenka's figures indicate. The distribution of the pedicels is also less regular than Selenka says for while the midventral series is distinctly double and for the most part sharply defined, it is ill-defined both anteriorly and posteriorly and the lateral series are much less clearly limited; dorsally the pedicels are widely scattered and no arrangement in longitudinal series is at all evident. This specimen was taken at Norwest Islet, Capricorn group, Great Barrier Reef, by Messrs. Boardman and Ward and was loaned by the Australian Museum.

HOLOTHURIA ALBIVENTER

SEMPER, 1868. Holothurien, p. 83.

The single specimen at hand is 90 x 25 mm. and the body wall is so hard as to suggest that it has at some time been dried. The very dark color (deep brown) and the crowded condition of the papillae confirm that suspicion, but the calcareous particles and the conspicuous white spots in which the ventral, and some dorsal, papillae are placed show that the specimen may be referred to *albiventer*. It belongs to the Western Australian Museum at Perth, was taken at Carnarvon and bears a metal tag with the number 7760.

HOLOTHURIA ARENICOLA

SEMPER, 1868. Holothurien, p. 81.

This common and widely distributed species does not seem to occur west of Torres Strait. It is common on the Barrier Reef, and at Lord Howe Island it is frequently found in the sand under rock fragments at Neds Beach. But neither at Darwin nor at Broome nor at any other point west of Torres Strait did a single specimen occur.

Some of the Lord Howe specimens deserve a little comment. The largest ones were as much as 275 mm. long (preserved the measurements are 230 x 25 mm.) and very light in color; my field notes say "almost pure white with dorsal spots yellow-brown, rather sharply defined." Other individuals were darker and had smaller, more numerous and less well-defined dark spots on the back. The smallest specimen taken, now 23 x 5 mm., was about 30 mm. long when living; the color was a "very pale translucent yellow, tentacles more distinctly yellowish." As the tentacles appeared on superficial examination to be dendritic and the pedicels were in double rows on the ventral ambulacra, I supposed before studying it carefully that the holothurian was a Cucumaria, and felt sure we had secured a specimen of the species listed by Etheridge (1889, p. 39) as "Cucumaria, of a pale straw color." As we found no Cucumarias at Lord Howe and the genus is relatively rare in Australian waters (though 10 species are listed from New Zealand), I am very strongly inclined to think that the specimen upon which Etheridge based his "Cucumaria" was also a young *Holothuria arenicola.* This would not be at all strange as neither Mr. Etheridge nor Dr. E. P. Ramsay, who assisted him in identifying his echinoderms, made any pretence of being a student of holothurians and all of the four species on the list were identified only tentatively.

The material at hand is as follows:

Lord Howe Island: Neds Beach, in sand under stones, 3 specimens, adult and young.

Queensland: Great Barrier Reef, Capricorn group, Norwest Islet. Boardman and Ward leg. 2 specimens, adult. Loan from the Australian Museum.

HOLOTHURIA ATRA

JAEGER, 1833. De Holothuriis, p. 22.

This common species has extended its range further to the west than has *arenicola* but we did not find it in the Broome region or at any point on the Western Australian coast. It does occur at Lord Howe however and Mr. Bardwell brought back a very typical specimen from Augustus Island, W. A., so we may consider that the vast extent of coast between those two islands is the Australian home of *atra*. Nevertheless we did not find *atra* at Darwin or in that vicinity in 1929. On the Coburg Peninsula however, in 1932, wherever we collected, Cape Don, Smith Point, Coral Bay (in Port Essington) and Allaru Island, *atra* was present and more or less common. At Cape Don, *atra* and *leucospilota* (*vagabunda* of many authors) occurred near together and it was possible to compare them side by side in life. The obvious differences were that *atra* is darker colored, usually quite black, while *leucospilota* is more brown; the body wall in *atra* is distinctly harder and more rigid; the appendages of *atra* are shorter and less papilla-like; and finally *atra* has no Cuvier's organs, the presence of which in *leucospilota* can be demonstrated easily enough, unless the animal has recently discharged them. Of course in preserved material the calcareous particles provide the distinctive characters. At Cape Don many specimens of *atra* were 400–500 mm. long. At Coral Bay, a small black holothurian attracted my attention because the margin of the periproct was very light, almost white. Critical examination of this specimen however fails to show any other character by which it differs from typical *atra*, so it must be considered merely an individual variant.

At Lord Howe Island, *atra* is one of the common holothurians and reaches a large size, up to 600 mm. It is very black but commonly covers itself with a sand coating which makes it much less conspicuous; often patches of this coat come off giving the animal the appearance of being sand color with large black blotches.

The material at hand consists of 4 specimens.

Lord Howe Island: April, 1932. 1 large specimen.

Northern Territory: Coburg Peninsula, Port Essington, Coral Bay. 2 small specimens (75–80 mm. long).

Western Australia: Augustus Island, October, 1933. Capt. B. E. Bardwell leg. 1 specimen.

Holothuria difficilis

Semper, 1868. Holothurien, p. 92.

This is one of the most widely distributed of Indo-Pacific holothurians, being recorded from Easter Island in the east, Mauritius in the west, southern Japan in the north and Lord Howe Island in the south. Moreover the species *captiva* occurring in the West Indian region is so closely related, it is very doubtful whether it can be maintained as distinct.

At Lord Howe, *difficilis* is one of the commonest holothurians, occurring on the under side of rock fragments on the reef-flat near Mt. Lidgbird as well as at

Neds Beach. The largest one taken was 125 mm. long (now 105 x 25 mm. in alcohol) which is a maximum for the species; the usual size is from 60 to 80 mm. in length. One individual (64 x 16 mm.) taken at Neds Beach is apparently a true albino; in life it was white (my field notes say "perfectly pure snow white") except for one patch of dark brown and the tentacles were very pale yellow; in the preserved specimen the white has become a light fawn-color and the tentacles are deep brown.

It is interesting to note that this species has not yet been taken on the Australian coast except in the Barrier Reef region[1] where it is apparently not rare, though it was not taken by the Barrier Reef Expedition at Low Isles. We failed to find it at the Coburg Peninsula, Darwin, Cape Leveque or Broome, nor did Mr. Bardwell find it at Adolphus Island. Yet at all these points local conditions seemed perfectly suited for it. Apparently it has never passed west of Torres Strait.

The material at hand consists of 16 specimens:

Lord Howe Island: April, 1932. 12 specimens, adult and young.

Queensland: Capricorn group, Norwest Islet, July 1929. Boardman and Ward. leg. 4 small adults. Loan from Australian Museum.

Holothuria edulis

Lesson, 1830. Cent. Zool., p. 125.

This well-known holothurian was not found by us during either the 1929 or 1932 expeditions but there is a single typical specimen in the present collection taken in July, 1929, by Messrs. Boardman and Ward at Norwest Islet in the Capricorn group, Queensland and loaned by the Australian Museum. There have been several other specimens recorded from the Barrier Reef region but apparently *edulis* has not yet reached Lord Howe Island or extended its range westward through Torres Strait.

Holothuria hartmeyeri

Erwe, 1913. Fauna Südwest-Australiens, **4**, pt. 9, p. 383.

This notable species was described from two specimens taken near Albany, on the southern coast of Western Australia, but the material at hand shows that its range extends eastward to South Australia and northward at least to Geraldton, where in October 1929, I found a large specimen (about 150 mm. long and 40 in diameter) on a "grassy" bottom in shallow water. The habitat and the appearance of the animal led me to suppose it was a Stichopus, and even in the preserved specimen, the lower surface seems to be flatter and provided with far more pedicels than the dorsal. About three weeks later, I dredged a somewhat smaller specimen at Bunbury and this has preserved its Stichopus-like appearance quite markedly. Three specimens from Garden Island (near Fremantle) are strongly contracted and their resemblance to Stichopus is very striking. Two specimens taken at Point Peron (below Fremantle) are longer and more slender than the others and hence more Holothuria-like in their present appearance. In life one was so like the specimen taken at Geraldton that in my field notes it is listed as Stichopus but the other which was quite different in color ("variegated grays and browns") is listed as "Holothuria sp.?" Erwe says his specimens had the anterior end injured but he thinks there were 18 tentacles; in the three largest specimens at hand I count 19, 19 and 20. No doubt the normal number is 20 in fully grown specimens.

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[1] Erwe (1913, p. 381) records three small specimens in the Perth Museum, supposed to be from Western Australia. I think there must be some mistake about either the locality or the identification.

Erwe's description of the color of his specimens fits two of my larger ones well, but there is a good deal of diversity both in life and in preserved material. Thus, one of my Point Peron specimens is said in my notes to have been a uniform brown while the other, as already stated, was variegated. The specimen taken at Bunbury was "light gray, pedicels darker; tentacles dusky; anal area black." The preserved material is either gray or a light grayish-brown, more or less finely variegated or vermiculated with rusty brown; or it is coarsely and irregularly variegated light and dark brown in several different shades; or it is approximately uniform brown of a dark shade, darkest dorsally. In typical specimens the dark tips of the pedicels are conspicuous, especially on the back and sides but in some individuals this is not at all striking.

The 9 specimens at hand are from the following places:

Western Australia: Geraldton, grassy bottom, shallow water near low tide mark, October 7, 1929. 1 adult.

Point Peron, in shallow water among rocks, October, 1929. 2 adults.

Garden Island. 3 specimens, badly contracted, 2 large and 1 small.

Bunbury; dredged in Koombana Bay, 5–8 fms., October 26, 1929. 1 adult.

Bunkers Bay, shallow water, January, 1930. E. W. Bennett leg. "On a patch of sand; the water was rather stagnant though by no means land-locked; there were large masses of Cymodocea leaves cast up on the sand and quantities rolling backwards and forwards in the ripple in a semi-decomposed state. The water was distinctly warm due not only to its shallowness and stagnation but also probably in part to decomposition" (E. W. B.) 1 specimen.

South Australia: Brighton Beach, May, 1923. 1 small strongly contracted specimen, probably adult. Loan from South Australian Museum.

HOLOTHURIA IMPATIENS

Fistularia impatiens FORSKÅL, 1775. Descr. Anim., p. 121.
Holothuria impatiens GMELIN, 1788. Linn. Syst. Nat. ed. XIII, 1, p. 3142.

This long-known tropicopolitan species is found on the coasts of northern Australia at many points. It is common on the east coast as far south at least as Low Isles and probably much further; on the west coast, it is recorded from two points in Shark Bay. We did not find it at Lord Howe Island or at Darwin but on the coast of the Coburg Peninsula, at Coral Bay, Port Essington, and at Allaru Island to the west, several typical specimens were taken, and at Cape Leveque and at Broome, it is a common holothurian and grows to a large size. The largest specimen preserved is about 175 mm. long by 35 mm. in diameter. All of this material from northern Australia is the typical variegated gray and brownish form, rather handsomely variegated when young but becoming dingy and more nearly unicolor when very large. The habitat is under rock fragments near low tide mark and several specimens are often found together.

At False Cape Bossut, southwest of Broome, a notable holothurian was taken in September, 1929, which is described in my notes thus: "Dull gray purple (very dark) with abruptly yellow papillae. A remarkable species. Very handsome." Examination of the calcareous particles and comparison with normal specimens of *impatiens* show that it is simply a striking color form of that species. It was found also in 1913, at Mer, Murray Islands, northern end of the Barrier Reef and in my Torres Strait Report (1921, p. 179) I say: "In some individuals from Mer the papillae are all yellow in handsome contrast with the purplish-brown background." At that time it seemed to me best not to give the variety a name but in view of its occurrence on the northwest coast and the ease with which it can be recognized, I have changed my mind and decided to call this conspicuous holothurian, *Holothuria impatiens* var. *bicolor*. This specimen (M. C. Z. No. 1521) from False Cape Bossut has retained its original coloration very well and may be considered the type. It is interesting how much like the Lord Howe specimens of *monocaria*, this form of *impatiens* is at first sight.

Only a few examples of *impatiens* were preserved, so the following are all that are in the collection at hand.

Northern Territory: Coburg Peninsula, Port Essington, Coral Bay, May 21, 1932. 2 large adults.

Western Australia: Augustus Island, October, 1933. Captain Beresford E. Bardwell leg. 1 adult and 1 young.
Cape Leveque, August, 1929. 1 small adult.
Broome, August, 1929. 2 adults.
False Cape Bossut, September, 1929. 1 adult, the holotype of variety *bicolor*.

HOLOTHURIA LEUCOSPILOTA

Stichopus (*Gymnochirota*) *leucospilota* BRANDT, 1835. Prod. descr. Anim. p. 251.
Holothuria leucospilota LUDWIG, 1881. Zeit. f. w. Zool. 35, p. 595. (See H. L. Clark, 1921. Torres Str. Ech., p. 179).

This common species occurs as far south on the eastern coast of Australia as Lord Howe Island and on the western as Shark Bay, whence Erwe (1913, p. 372) reports 3 adult specimens. Ekman (1918, p. 63) records a small specimen from Broome. Both these authors use Selenka's much more satisfactory name *vagabunda* but unfortunately, unless Ludwig has made a bad blunder which seems highly improbable, the much older and very inappropriate name given by Brandt must be used.

At Lord Howe Island, *leucospilota* was found on the reef-flat near Mt. Lidgbird but was not very common. My field notes say: "Deep brown; tentacles blackish; Cuviers organs evident on handling." At Darwin, in 1929 this was the first holothurian found. My notes say: "Very common and reaching a large size (over 500 mm. when well extended), at East Point, not found at Casuarina Beach.

At first supposed to be *atra* but voluminous white Cuvier's organs showed the mistake. Always uniformly bright brown when examined in strong light with skin well extended but much darker when in poor light or when more or less contracted. Appears nearly or quite black on reef many times; often a little dirty from silt but on the whole a very clean species. Small ones on under side of stones resemble *difficilis!* Abundant on flat at Quail Island." In 1932, this species was found on the Coburg Peninsula, at Cape Don and at Coral Bay, Port Essington. At Broome, *leucospilota* was common at Gantheaume Point and was also seen at Entrance Point; later we found it at False Cape Bossut.

The only specimens of this species preserved are the following:

Lord Howe Island: reef-flat near Mt. Lidgbird, April, 1932, 1 large specimen.
Northern Territory: Coburg Peninsula, Port Essington, Coral Bay, May 21, 1932. 1 small adult.
Darwin, East Point, June, 1929. 2 adults and 3 young.

Holothuria marmorata

Bohadschia marmorata Jaeger, 1833. De Hol. p. 18.
Holothuria marmorata Semper, 1868. Holothurien, p. 79.

This holothurian was met with only once, when 5 specimens were brought up by Wan, the diver, June 15, 1932, from 5–7 fms., off North Head, northeast of Broome. My field notes say: "A large species 300–350 mm. long and 75–100 mm. in diameter, tapering about equally towards the two end. Lower surface white; upper very pale brown with 2 or 3 large irregular areas of a light yellow brown; tentacles gray-brown, darker than the body. Pedicels fairly numerous, uniformly (?) distributed over the body. Body wall with a very soft (not slimy) appearance and feel. Cuvier's organs profuse, translucent white as usual. Cloacal inner surface dark brown. The coloration is identical in the 5 specimens (only 3 kept for the M. C. Z.) though the dorsal patches do not agree in size or position." In the preserved specimens the color is a dingy grayish-brown, somewhat darker dorsally than ventrally; the very small and numerous pedicels are conspicuously and abruptly dark brown, and are somewhat more numerous apparently on the ventral surface. The largest specimen is now about 225 mm. long by 70 in diameter.

HOLOTHURIA MICHAELSENI

ERWE, 1913. Fauna Südwest-Australiens, **4**, pt. 9, p. 384.

The unique holotype of this species, conspicuous because of its striking coloration, was taken near Denham, in Shark Bay. It was therefore a surprise and pleasure to rediscover it again near Broome. Mr. Bourne found two specimens, 70–90 mm. long, half buried in sand in a tide pool near low water mark, at False Cape Bossut, Sept. 9, 1929. They were perfectly "black with 5 longitudinal pure white stripes in startling contrast; 20 whitish tentacles." These specimens now measure 53 x 20 and 60 x 25 mm. The black color is somewhat brownish, the white is dingy and the tentacles are pale brown but the color contrasts are striking enough. As Erwe's unique specimen was imperfect, I can complete his description not merely by giving the number of tentacles but by adding also that there is, in the specimen 60 mm. long, 1 rather large Polian vessel, 1 long and conspicuous madreporic body, and an unexpectedly stout calcareous ring. This has radial pieces 4 mm. high and almost 2 mm. wide, truncate at both ends and projecting conspicuously both anterior and posterior to the much smaller interradial pieces which are scarcely 2 mm. high, pointed in front and markedly concave posteriorly.

In 1932, we met with the species again but this time to the north of Broome in Pender Bay, where on June 16, Wan, the diver, working in 5–7 fms., brought up an individual about 100 mm. long, which my notes describe as "black (brownish) with the five radii white; tentacles white."

A fourth specimen lies before me, the property of the Western Australian Museum, and labelled "Carnarvon." It is so strongly contracted that the white stripes which are somewhat stained are considerably obscured but I do not think there is any doubt about the identification. At present the specimen is 70 x 27 mm. but in life it was almost certainly over 125 mm. long.

HOLOTHURIA MODESTA

LUDWIG, 1874. Arb. Zool.-Zoot. Inst. Würzburg, **2**, p. 106.

This is one of the commonest holothurians at Broome, and along shore to the southwestward, but we did not find it at any other place on the Australian coast. The type locality is Cape York and it is also known from some of the islands in Torres Strait. It was not taken by the Great Barrier Reef Expedition at the Low Isles but a typical specimen at hand belonging to the Australian Museum was collected at Port Curtis. Erwe (1913, p. 382) records two badly preserved specimens from Cockburn Sound, below Fremantle, but points out several differences from Ludwig's account and suggests that it is possible his specimens represent a different species. In view of their small size and poor condition, it seems to me that they may be young individuals of *Stichopus mollis*.

At Broome, *modesta* occurs from above low water mark to a depth of at least 7–8 fms. It is a very inert animal clinging rather closely to the under surface of rock fragments, where its coloration renders it inconspicuous. It is, even when young, variegated with various shades of brown, gray, purple, yellow and white (not that all are evident in one specimen); the general effect ranges from very light, almost a dirty white, to very dark, almost blackish. The tentacles are generally yellow but may be cream-color or whitish; the pedicels are usually more or less yellowish at tip, sometimes quite yellow. The specimens taken range from 10 mm. in length to nearly 125; the form is somewhat depressed, especially in the larger individuals, which may be 20 mm. wide. The contrast between the flattened ventral side with its three more or less ill-defined series of pedicels and the arched dorsal surface with numerous, small, irregularly disposed papillae is usually quite evident, but in young individuals and in many preserved adults it is not very obvious.

The 33 specimens at hand are from the following places:

Queensland: Port Curtis. Boardman and Ward leg. 1 adult. Loan from Australian Museum.

Western Australia: Broome, chiefly from under rocks along shore, August and September, 1929. 18 specimens, adult and young.

Broome, chiefly dredged in 5–7 fms., June, 1932. 12 specimens, adult and young.

Off Cape Jaubert, 5 fms., sandy bottom, June 8, 1932. 2 very small young.

HOLOTHURIA MOEBII

LUDWIG, 1883. Ber. d. Oberh. Ges. f. Natur. -u. Heilkunde, p. 171.

The discovery of this apparently rare holothurian at Lord Howe Island was one of the most unexpected of our surprises. The original description was based on six small specimens from Hong Kong in the Kiel Museum. Théel (1886, p. 206) has reported a specimen in the Stockholm Museum from Mauritius. Mitsukuri (1912, p. 89) lists a large number of specimens from southern Japan, the Bonin Islands and the Philippines under the name "*Holothuria lubrica* var. *moebii* Ludwig." It seems probable that most, if not all, of these represent Ludwig's species which thus appears to be common in southern Japan.[1]

There is a specimen of *moebii* from Hong Kong in the M. C. Z. collection but apparently there was none in the collection from that place sent by Professor Herklots to Dr. Mortensen and recently reported on by Heding (1934). Comparison of the Lord Howe Island specimen with one from Hong Kong has thus been possible. There has also been available an eviscerated and strongly contracted specimen (80 mm. long by 20 in diameter) from Southwest Bay, Malekula, New Hebrides, belonging to the Australian Museum, collected by Mr. McAfee. The calcareous deposits agree well with those of the Hong Kong specimen.

The individual taken at Lord Howe Island was found under a stone on the reef-flat near Mt. Lidgbird on April 4, 1932. My notes add: "brown, feet yellowish, crowded on ventral surface; not recognized." The preserved specimen is 110 x 30 mm. and deep, rich brown in color; the contrast between the ventral surface with the very numerous crowded pedicels and the dorsal surface with many but irregularly scattered pedicels is very striking. The fact that no other specimen of *moebii* was found during the three weeks of intensive collecting at Lord Howe indicates that it belongs to that tantalizing group of echinoderms whose normal habitat is well below low water mark on the face of the reef where shore collecting and dredging are alike impossible.

HOLOTHURIA MONOCARIA

Plate **16**, fig. 7

LESSON, 1830. Cent. Zool., p. 225.

This is one of the common holothurians of the eastern coast of Australia that has not as yet reached Broome or the western coast, though we found it rather common at Cape Leveque. At Lord Howe Island it occurs in some numbers at Neds Beach, where specimens up to and exceeding 400 mm. in length were found.

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[1] I am quite unable to accept Mitsukuri's opinion that *moebii* is only a variety of *lubrica* and that the latter, a Panamic species described by Selenka, is a protean and wide-spread form, including also the West Indian *glaberrima*, the South African *parva*, the Indo-Pacific species *erinaceus* Semper and *marenzelleri* Ludwig. That this group of species needs critical study and revision seems evident but the task cannot be undertaken here.

All were dark brown with the papillae and pedicels deep yellow in marked contrast. No specimens were found on the western side of the island.

At Allaru Island, west of the entrance to Port Essington on the Coburg Peninsula, *monocaria* was found to be rather common. But they were much lighter colored than at Lord Howe, the ground color being a bright chestnut-brown and the papillae and pedicels light yellow. In some large individuals, brown of a darker shade formed irregular longitudinal bands on a somewhat lighter background and the yellowish papillae had the tips "bright grass green, extending down on the papillae more or less, often including the whole papilla." As the green disappears entirely in alcohol, it is doubtful whether a varietal name is worth while, but in order that this very handsome and distinct form may be referred to easily, I will designate it as variety *viridis*. (Holotype, M. C. Z. no. 1535.)

At Cape Leveque, the specimens of *monocaria* which we found, and they were by no means rare, were much like those from Allaru Island, but none showed any trace of green in the coloration. The ground color was a light chestnut brown (darker in large specimens) while the tentacles and basal part of the papillae were white; the papillae as a whole were bright yellow but the larger ones had the very tips dark. The superficial difference between these light individuals from the northwest coast and the dark ones from Lord Howe Island is striking enough, but the calcareous particles are indistinguishable.

The 16 specimens of *monocaria* at hand are from the following places:

Lord Howe Island: Neds Beach, April, 1932. 6 specimens.
Queensland: Capricorn group, Norwest Islet. Boardman and Ward leg. 1 badly contracted specimen. Loan from Australian Museum.
Northern Territory: Coburg Peninsula, Allaru Island, May 22, 1932. 3 specimens, adult and young, including the holotype of var. *viridis*.
Western Australia: Cape Leveque, August 20–22, 1929. 6 specimens, adult and young.

HOLOTHURIA OCELLATA

Bohadschia ocellata JAEGER, 1833. De Holothuriis, p. 19.
Holothuria ocellata SEMPER, 1868. Holothurien, p. 80.

This species is not so conspicuous in life as Théel's figure (1886, pl. XVI, fig. 1) would lead one to suppose but the encircled papillae do make a fairly good recognition mark. At Broome, *ocellata* was taken both in 1929 and 1932 but it is distinctly uncommon, and we did not meet with it at any other place, but Captain Bardwell took a very typical specimen at Augustus Island. The general coloration of the specimens from Broome is much darker than that described by Théel but the pattern is essentially the same. The individual from Augustus Island however shows very much more white. The calcareous particles are well figured by Théel (1886, pl. VII, fig. 11) but the tables, in these specimens from the northwest coast, have the margins of the disks usually with projecting spines and the spires with fewer terminal teeth and a larger opening. The 5 specimens at hand are all adults 100–120 mm. long by 20–40 mm. in width. The marginal papillae are not nearly so conspicuous as in Théel's figure and description, but there seems to be no little diversity in this character. In one of the specimens from Broome they are evident enough and in the Augustus Island specimen they are really conspicuous, but in the largest specimen, they are small and fail to form any evident marginal series.

HOLOTHURIA PARDALIS

SELENKA, 1867. Zeit. f.wiss. Zool., **17**, p. 336.

This common, widespread but rather ill-defined species ranges west and east from Mozambique and the Red Sea to the Paumotus and Hawaii, north and south from southern Japan to Lord Howe Island. Records from the southern coasts of Australia and from the Falkland Islands need confirmation; there is little doubt that they are erroneous.

At Lord Howe Island, *pardalis* is one of the commonest holothurians. The largest one taken is 110 x 20 mm. and is an admirable example of Ludwig's species *insignis*. Most of the smaller specimens answer perfectly to the description of *lineata* Ludwig. It is now generally agreed that these names are synonyms of *pardalis*[1]. Specimens under 50 mm. in length are easily confused with young *arenicola*, owing to the double series of dark dorsal spots so often present in both species. Like *arenicola*, *pardalis* is an inert species found under rocks, often several together. The color is very indistinctive and shows great diversity.

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[1] Heding (1934) has recently expressed the opinion that *insignis* is distinct from *pardalis* and I agreed with him until the final critical study of my present material convinced me that the distinction is unnatural and cannot be maintained.

Both Fisher (1907) and Mitsukuri (1912) have published good discussions of the diversity shown by *pardalis* so it is not necessary to go into the matter here.

The discovery of this species on the Coburg Peninsula, at Cape Leveque, at Broome, and as far west as False Cape Bossut is important as showing the extension of its range west of Torres Strait. It is not known from the western coast of Australia.

The material at hand consists of 42 specimens from the following localities:

Lord Howe Island: April, 1932. 9 specimens, adult and young.

Queensland: Capricorn group, Norwest Islet. Boardman and Ward leg. 2 specimens, adult and young. Loan from Australian Museum.
  Port Curtis, shores of Rat and Curtis Islands, 1929. Boardman and Ward leg. 16 specimens, adult and young. Loan from Australian Museum.
  Bowen. 2 very young specimens. Loan from Victoria National Museum.

Northern Territory: Coburg Peninsula, Allaru Island, May 22, 1932. 2 small adults.

Western Australia: Cape Leveque, August 20–22, 1929. 1 specimen.
  Broome, August and September, 1929. June 1932. 9 specimens, adult and young.
  False Cape Bossut, September, 1929. 1 young specimen.

HOLOTHURIA PERVICAX

SELENKA, 1867. Zeit. f.wiss. Zool., **17**, p. 327.

Oddly enough, Lord Howe Island is the only locality where we met with this species, which is common at the northern end of the Barrier Reef. At Lord Howe, it was not particularly common but we found it both at Neds Beach and on the reef-flat near Mt. Lidgbird. The specimens were all large (125–150 mm.) and the coloration was much like that shown on plate 19 of my Torres Strait Report (1921); the preserved specimens are much darker and are of course much smaller.

Erwe (1913, p. 379) unites *pervicax* Selenka with *fuscocinerea* Jäger, giving the latter name priority of course. I am not able to agree with this as the calcareous particles in the two species are quite different. The tables to be sure are scarcely separable but the other particles are unlike and the difference is well shown in the figures given by Selenka (1867, pl. XVIII, fig. 54) and Semper (1868, pl. XXX, fig. 22). Both species occur in the Torres Strait region but there is no difficulty in separating them. It is obvious that they are closely related but it seems to me a mistake to unite them under one name. I suspect that Semper however has both forms confused under Jäger's name, just as Erwe has.

Erwe (1913, p. 379) reports a specimen from Shark Bay, which he calls *fuscocinerea*. The figures which he gives of the secondary calcareous particles however, remind one more of *pervicax* and the description given of color and appearance leaves no doubt that he was dealing with that species. It is hard to understand why *pervicax* should occur in Shark Bay and yet not be found at Broome or anywhere else on the northwestern or northern coasts west of Torres Strait. It is therefore probable that further collecting will discover its presence there.

Holothuria scabra

Jaeger, 1833. De Holothuriis, p. 23.

This is one of the largest members of the genus and the size, taken in connection with the black, or gray, and white color, makes it easy to recognize even without examination of its characteristic spicules. Its range is throughout the Indo-Pacific region, though it is not yet reported from east of Fiji. It reaches southern Japan in the north and Lord Howe Island in the south. Mitsukuri (1912) has given an excellent account of this species with notes on the coloration in life. The only living ones I have ever seen were those listed below from Darwin and Lord Howe Island. My field notes on these may be worth transcribing. Of the Darwin specimen my notes say: "Large, gray above, white below, tentacles white. Dredged on sandy mud near Channel Islands, July 18. Over 200 mm. long, 60 mm. in diameter. The very small dorsal papillae are dark tipped and the ventral pedicels are surrounded by dusky rings." This individual has undergone little change in alcohol except that the length is now only about 170 mm., the width is about 60 but the vertical diameter is scarcely half that. Of the Lord Howe specimen, my notes say: "One fine one at the reef-flat near Mt. Lidgbird, over 300 mm. long by 60–70 mm. in diameter. Light brownish-gray, brownest on back; lower surface nearly white. But whole surface densely encrusted with sand. Tentacles light reddish-yellow." The preserved specimen has lost its encrusting sand and is grayish-white finely speckled with blackish; the speckling is much more abundant ventrally than dorsally; hence the ventral side appears much darker, which is quite unusual; the tips of the pedicels are yellowish. The shrinkage in alcohol is very great as the measurements now are, length a little over 200 mm., diameter about 50 mm.

There are 9 specimens of *scabra* at hand from the following places; it is notable that the species is not known on the Australian coast west of Darwin.

Lord Howe Island: reef-flat near Mt. Lidgbird, April 19, 1932. 1 specimen.
Queensland: Capricorn group, Norwest Islet. Boardman and Ward leg. 1 nearly cylindrical, strongly contracted and probably eviscerated adult. Loan from Australian Museum.
Port Curtis, shores of Rat and Curtis Islands, July, 1929. Boardman and Ward leg. 6 specimens, small and moderately large adults. Loan from Australian Museum.
Northern Territory: Darwin, near Channel Island, on sandy mud, July 18, 1929. 1 specimen.

Holothuria conica[1] sp. nov.

Length 80 mm.; diameter about 18 mm. Specimen strongly contracted, with bodywall collapsed and much wrinkled; skin thick and very rough with the spires of the innumerable and densely crowded tables. Tentacles small, strongly contracted and apparently damaged; their number is doubtful but presumably 20. Pedicels surprisingly few and papilla-like; on the ventral surface they are most like pedicels and seem to have disks but on the dorsal surface the tips are very small and hardly disk-like; even ventrally they are set on papilla-like bases. Calcareous ring low but fairly stout; the radial pieces have broad, truncate but rounded projections anteriorly to which the muscles are attached; the much smaller interradial pieces end anteriorly in a low sharp point. Polian vessel, single. Madreporic body, single and very small. Cuvier's organs well developed.

Calcareous particles extremely abundant, an outer layer of tables and a dense inner layer of buttons. Tables (fig. 55a) of moderate size, with the smooth-margined disks about 80–90μ in diameter and the spires 75–100μ in height; lower surface of disk more or less convex, often very slightly so but often markedly; disk irregularly perforated with holes of very diverse size; even the marginal series is not often regular; spires with 3–6 crosspieces and more or less numerous, small, sharp pointed teeth at the tip and often for some distance down on the corners;

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[1] *conicus* = like a cone, in reference to the shape of the calcareous tables.

owing to the small size of the tip and the divergence of its supporting pillars basally, the tables have a more or less conical shape; when the disk is large and the spires high, as in many tables in the walls of the pedicels, this appearance is lacking but in the average table with a lower spire and a smaller disk it is rather marked. Buttons (fig. 55b), with 3–5 pairs of holes, usually with 3, sometimes with fewer, mostly short and wide, 50–60μ in length and 35–40μ in width; few, if any, are perfectly smooth, but the number and size of the knobs on the surface show great diversity; in the simplest cases there are 2 knobs on the median area, then knobs appear on the lateral areas, and in the most developed buttons there may be 4 or 5 knobs on the median and half a dozen on each of the lateral areas. Supporting rods in pedicels short, wide and stout, more or less perforated either near middle or towards one end or both. So far as I can see, there are no end-plates present even in the best developed pedicels. Around the anus, there are 5 groups of about 5 papillae each, more or less calcified.

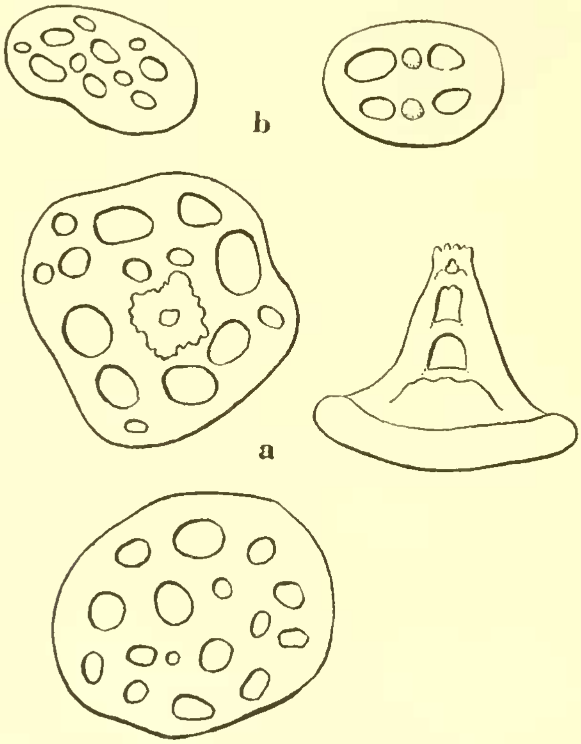

Fig. 55. Holothuria conica. Calcareous particles. x 425. a. Tables. b. Buttons.

Color in life, variegated purplish-gray and whitish; tentacles pure cream white. The preserved specimen is dirty whitish finely variegated with brown; dorsal side quite brown; posteriorly and ventrally lighter; tentacles dusky.

Holotype, M. C. Z. no. 1547, from Quail Island, 35 miles west of Darwin, Northern Territory, July 8, 1929.

Taken with the holotype is a much smaller and even more contracted specimen in which the pedicels seem to be relatively larger and more conspicuous. But the difference is insignificant and probably due to its being less mature. These two specimens were found in sandy mud under rocks in a tide-pool at Quail Island. The larger was nearly 150 mm. long in life, the smaller about half as large. It seems odd that we did not find this species elsewhere but what is even more strange is the fact that a third specimen is at hand, the property of the South Australian Museum at Adelaide, which is labelled as having been taken at Semaphore, Le Fevre Peninsula, South Australia. This specimen is about 90 mm. long by 18 in diameter, with the body wall collapsed and much wrinkled. The color is creamy white, with a distinct brownish tinge on the back; it has probably been bleached by the alcohol. In no essential does this specimen differ from those taken at Quail Island across the continent, and it seems to me that there must be some mistake in the label. The relationships of the species are obscure and more material is much to be desired.

Holothuria homoea[1] sp. nov.

Length 46 mm., diameter 8 mm.; body nearly cylindrical but tapering a little towards each end; the ventral surface is a little more flattened than the dorsal and its lateral pedicels tend to form an indefinite margin between the two; body wall thin and delicate. Pedicels very few, perhaps 200 altogether; those of the dorsal surface are fewer and most of them smaller than the ventral ones, irregularly scattered, often papilliform with tapering tips; on the ventral surface, the pedicels are arranged in three ill-defined double series; as already stated, the lateral series form, at least near the middle of body a slight margin to the ventral surface; there are no noticeable papillae around the anus. Tentacles 20, of moderate size. Calcareous ring not peculiar, the radial pieces larger than the interradial, with wider, blunter anterior projections. Alimentary canal so filled with coral and, chiefly in coarse fragments, that the body is quite rigid and it is not practicable without needless damage to the specimen to study the internal anatomy. Cuvier's organs seem to be present but rather scanty.

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[1] ὅμοιος = *like, similor to,* in reference to the similarity of the calcareous particles to those of several other species.

Calcareous particles, numerous, but not at all crowded, tables and rather few, irregularly distributed, buttons. Tables (fig. 56a) with disks nearly circular, about 50–70 μ in diameter, with 4 central holes and 8–12 in a peripheral series; spire rather low, seldom exceeding the disk diameter and very rarely with more than one cross-bar; apex truncate, almost square, with a small but distinct circular central opening, and 8–10 teeth on the margin. Many tables have the disk less complete and what are apparently young tables, having a squarish disk with a perforation at each corner, are not rare. Buttons (fig. 56b) as irregular in form as in distribution; the commonest form has two long, narrow, parallel slits and these buttons are often only 20μ long and 10 wide, but many are 30–40μ long by about 15μ wide; these larger buttons usually have 2 pairs of elongated

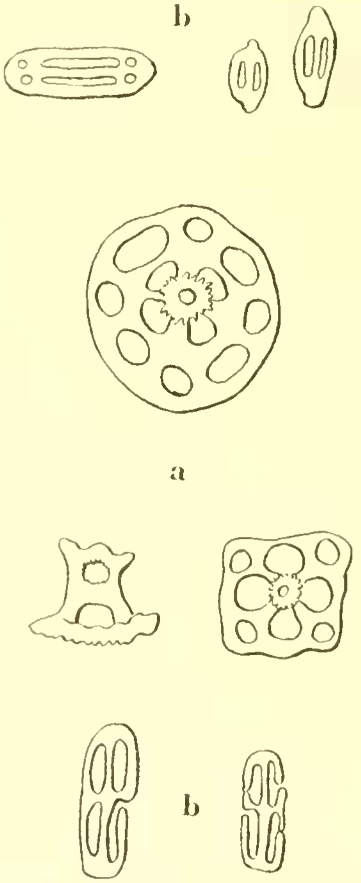

Fig. 56. Holothuria homoea. Calcareous particles. x 425. a. Tables. b. Buttons.

perforations or a single pair of long ones and a pair of small circular ones at each end; all sorts of incomplete and malformed buttons occur. Supporting rods and end plates occur in the pedicels but the rods are more or less button-like with perforations of various size and arrangement.

Color in life is recorded as "uniformly red brown" but the preserved specimen is a peculiar light purplish-gray; on one side the margin of the dorsal surface is quite evidently purplish-red but this is not marked on the other side; tips of pedicels brown or deep purple in more or less marked contrast to the pedicel itself and the body wall; tentacles a rather dark brown.

Holotype and only known specimen, M. C. Z. no. 1549, from "under a rock, far out at Neds Beach, Lord Howe Island, April 21, 1932."

My field notes say of this puzzling holothurian — "1 small specimen, uniformly red-brown; few pedicels; no Cuvier's organs; tentacles dark brown; nearly cylindrical; 50 mm. long ±. At first confused with *difficilis* but really very different." Of course the statement about Cuvier's organs merely indicates that the living animal did not discharge any, as *difficilis* and others do.

Owing to the small number of pedicels and their arrangement in series (even though so indefinite) I was inclined to consider this specimen a young Labidodemas but I was soon convinced its affinities are not with that group at all. In looking for a species of Holothuria to which it could be assigned, particular attention has been given to Heding's (1934, p. 24) recently described *dicorona*, but that species has normally numerous pedicels and its calcareous tables and buttons while suggestive of those found in *homoea* show certain apparently uniform differences.

Another possibility that occurs to me is that this peculiar holothurian is a young and pathological specimen of *leucospilota*, but I cannot believe this is the case, and hence I am giving it a name and place among the Australian members of the already overcrowded genus Holothuria.

HOLOTHURIA MACROPERONA[1] sp. nov.

Length 17 mm., diameter 5 mm., body form depressed so that a fairly well defined ventral surface can be distinguished from a more convex dorsal side; body wall thin, translucent and densely crowded with calcareous particles, so that it feels, in many of the preserved specimens, stiff and rough. Pedicels relatively large not numerous and pretty closely restricted to the ambulacra, converging at the anus into a rather conspicuous group, those of the dorsal ambulacra taper more or less to a tip which is not so truncate as might be; hence the dorsal pedicels are often quite like papillae; in some particularly well preserved specimens this distinction between the dorsal and ventral sides is very well marked but in other cases, it is scarcely noticeable; it is probably however, more a matter of preservation than of individual diversity. On the dorsal interambulacra are a few widely scattered small pedicels. Tentacles 20, surrounding an oral disk somewhat ventrally placed, and themselves surrounded by a marginal fold which includes a number of pedicels; the whole is much like the oral disk in Stichopus and of course is evident only in fully expanded individuals; it is not well shown in the holotype. Calcareous ring low, rather stout relatively, with the radial pieces having the usual wide truncate anterior projections to which the longitudinal muscles are attached and the interradial pieces with short anterior points. No madreporite or polian vessel noted in the holotype, but the single genital tuft on the left hand side is very evident and in the two specimens examined contained numerous relatively large eggs. Cuvier's organs well developed.

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[1] μακρός = *long* + περόνη = *button*, in reference to the unusually long buttons.

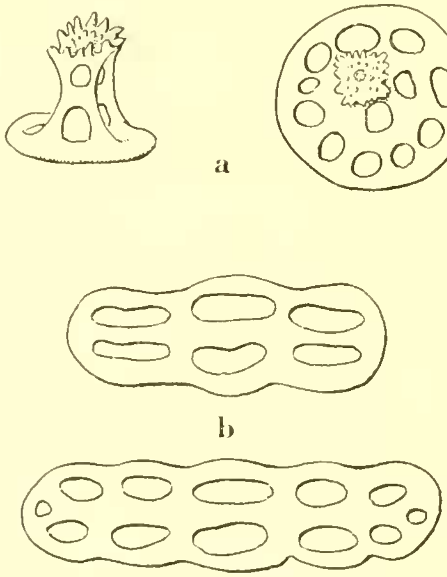

Fig. 57. Holothuria macroperona. Calcareous particles. x 425. a. Tables. b. Buttons.

Calcareous particles excessively abundant in the form of tables and buttons. Tables (fig. 57a) with disks about 70μ in diameter, usually with smooth more or less circular margins but some of the largest tables, in the walls of the pedicels, have the margin more irregular and somewhat dentate; the disks have a peripheral series of 9–11 holes, which are unequal in size and irregular in position; occasionally there are perforations outside this circle; spires about 40–50μ high, commonly with only one cross-bar and with numerous teeth all over the top. Buttons (fig. 57b) notably long and narrow, with 3 or more pairs of elongated, more or less slit-like, perforations; typical buttons are 100μ or more in length and their width about one-third as much, but many buttons exceed 130μ in length and their width may be only one-fourth as much; the longer buttons often have a single small perforation at each end. Pedicels with a well-developed end plate and supporting rods which are wide and perforated on each side, and which appear to intergrade with the long buttons.

Color in life pale gray or sand color in harmony with the surroundings; the preserved specimens range from almost white, quite uniform, to light brown; some are distinctly gray; tentacles light brown.

Holotype, M. C. Z. no. 1546, from cove at Northeastern corner of Rottnest Island, Western Australia, October 19, 1929.

Besides the holotype there is a good series of paratypes all from Rottnest Island. They live on the under surface of rock fragments on sandy bottom and might easily escape observation if the search were not keen. There is little diversity in size of the individuals, except such as is caused by the difference in the amount of contraction. The Stichopus-like appearance of some of the specimens, and the calcareous particles are very suggestive of *H. hartmeyeri* and I have seriously considered calling these little holothurians, the young of that large species. But the presence of mature ova in these little individuals seems to preclude such a course.[1] Furthermore the differences in the calcareous particles are not such as can well be explained by the youthfulness of the specimens. On the whole it seems best to regard *macroperona* as a distinct and perhaps local species, but it would be most interesting to compare young *hartmeyeri* of the same size with this little Rottnest Island form.

The material at hand is made up of the following lots:

Western Australia: Rottnest Island, cove at northeastern corner of island, Oct. 19, 1929. 8 specimens.

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[1] Dr. Deichmann calls my attention to the fact that some unpublished observations on *Thyone briareus* (Les.) indicate that very small, and presumably young, individuals may have a few fully grown eggs in the gonads. Hence the presence of such eggs is not evidence of bodily maturity. However in *macroperona*, the eggs are fairly numerous in the gonads.

Bathurst Point. 6 specimens.

Exact locality? January, 1931. G. Bourne leg. 1 specimen.

ACTINOPYGA LECANORA

Mülleria lecanora JÄGER, 1833. De Holothuriis, p. 18.

Actinopyga lecanora BRONN, 1860. Das Thierreich, **1**, pl. XLV, explanation of figs. 10, 11.

It is curious that this is the only species of Actinopyga, met with during the two Australian expeditions, while Erwe (1913) records both *echinites* and *nobilis* from Shark Bay and does not mention *lecanora* at all. Both *nobilis* and *lecanora* were found in Torres Strait in 1913, but I have not yet met with *echinites* anywhere.

Of the four specimens before me, the two larger were taken at Cape Leveque in August, 1929. They were wedged in among living corals and it was no easy task to secure them. They have of course shrunk much in preservation but still measure 160 x 80 and 260 x 50 mm. The colors have not changed so much; they are still deep brown with the lower surface and the area around anus, pale gray; in the smaller specimen, there are some gray patches on the back.

In 1932, we secured two rather small specimens in the region of Broome. One of these brought up by Wan the diver, off North Head, was 130 mm. long by 35 mm. in diameter when alive. In my notes it is described thus: "Deep brown-black above, somewhat lighter below with a definite olive tint; tentacles also very dark, quite olive; anal area light gray, adorally almost white when distended. Papillae dorsally few, widely scattered, 2–3 mm. long, very slender, probably pedicels as they are truncate at tip. Ventral pedicels larger and much more numerous but not crowded. Anal teeth, and collar around tentacles, conspicuous in fully distended specimens."

MOLPADIIDAE

MOLPADIA ALTIMENSIS[1] sp. nov.

Length about 23 mm., of which only 2 or 3 can be considered as caudal; diameter of body 8 or 9 mm. Caudal portion evident but very short and not sharply defined proximally. Oral disk about 3.5 mm. across surrounded by 15 very short tentacles; those which are most expanded have 3 digits of about equal length, a terminal one and one on each side; this is probably the normal condition in life, but in the preserved material, the terminal digit is usually hard to see. Calcareous ring well developed, relatively stout, the radial pieces with well marked posterior prolongations, the length of which nearly or quite equals the height of the ring. Body wall thin and delicate but rough from the very numerous tables. Calcareous particles tables and a few scattered anchors; there are no rods nor are the disks of the tables elongated even in the "tail." Tables (fig. 58a) with a disk about 75μ in diameter, perforated by three large holes, and usually three smaller ones alternating with them; there may be one or more still smaller perforations alternating with these; spire usually higher than diameter of disk, made up of three rods, each terminating in an acute point, connected by 5–8 cross-bars. In the tail, the tables (fig. 58b) are lower and smaller, the disks with small perforations and the low, stumpy spires with only 2 or 3 cross-bars. Many tables in the body wall are changing into phosphatic bodies but the color is still light, and there are no distinct, fully developed phosphatic granules. Anchors (fig. 58c) 80–90μ long with a circular base, perforated near the middle, and terminating in 4 recurved teeth; they are not associated with any plates. Color pale gray, more or less rusty; in one specimen the rust color is so conspicuous as to seem artificial; oral disk, tentacles and tip of tail, translucent white.

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[1] *altus* = high + *mensa* = table, having high tables, in reference to the calcareous deposits.

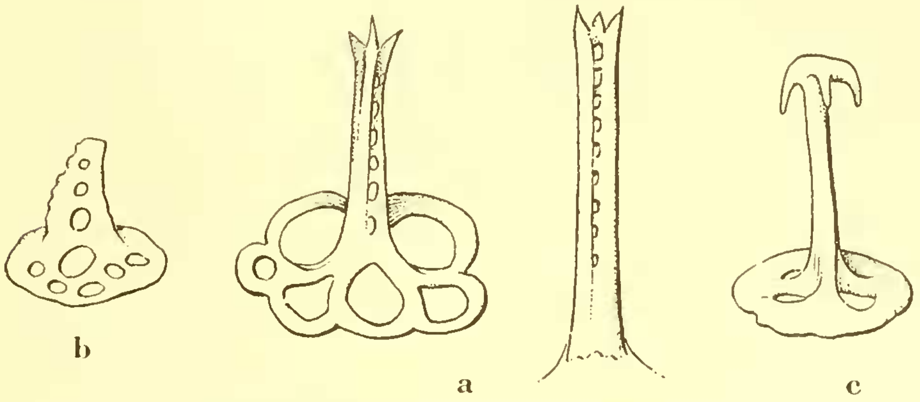

Fig. 58. Molpadia altimensis. Anchor and Tables. x 425.

Holotype, M. C. Z. no. 1681, and 2 paratypes, from Darwin, N. T.; dredged in soft, black mud, near jetty in 7 fms., July 1 and 4, 1929.

While these specimens may not be fully grown, they probably show fairly well the adult characters, which are quite distinctive. The tables transforming into phosphatic bodies almost certainly indicate immaturity. The numerous small tables in a delicate body wall and the absence of rods recall at once *M. blakei* but the actual form of the tables is very different from those of that species and the presence of anchors confirms the lack of identity. The anchors remind one of those in *M. polymorpha* but in other respects that species is very different. Moreover both *blakei* and *polymorpha* are deep-water forms whose occurrence in shallow water at Port Darwin would be very surprising, if not impossible. Dr. Deichmann, who has studied the "Siboga" material in Amsterdam, calls my attention to the possibility that *altimensis* is a shallow-water form of *Trochostoma scabrum* Sluiter or even the young of that species. The resemblances are striking and the differences might be due to difference in age but the tables in *altimensis* are much smaller than in *scabrum* and the anchors are entirely different, so that it seems best to treat it as a separate species until more material from northern Australia is available.

PARACAUDINA CHILENSIS var. RANSONNETII

Caudina ransonnetii v. MARENZELLER, 1881. Verh. k. k. Zool.-Bot. Ges. Wien, **31**, 126.
Paracaudina ransonetti HEDING, 1932. Vid. Med. p. 455.
Paracaudina chilensis var. *ransonnetii* H. L. CLARK, 1935. Ann. Mag. N. H. (10) **15**, p. 281.

It was a great surprise and a very interesting experience to find this notable holothurian common in the sandy mud of Roebuck Bay, near the jetty at Broome. The specimens secured were all taken by random digging at or just below low water mark. I failed to detect any evidence on the surface of the mud (a firm sandy mud on which one could walk easily) of the existence of the holothurians but it is not unlikely that some of the numerous small holes in the mud were associated with them. Nearly all the individuals taken were adults with the body 80 mm. long or more and the tail 55–75 mm., but some young ones were found, the smallest having the body only about 30 mm. long and the tail somewhat shorter. In life the body is white with a slight purplish cast especially near the anterior end; the caudal portion is cream color; the tentacles are reddish at base and on the outer side, apparently from the blood they contain. My field notes say: "They stand out in marked contrast." The preserved specimens are light gray. A careful comparison of these specimens with those of similar size from Asamushi, Japan, reveals a striking similarity; the only tangible difference is that the spicules average perceptibly smaller in the Australian specimens; in the Japanese specimens the spicules are 60–80μ in diameter while in those from Broome, they are 60–65μ. There are 15 specimens in my material from Broome, most of which were taken in the afternoon of September 1, 1929. It is evident that the species must be very common, or haphazard digging with a spade would not have produced so many specimens, but they are not at all gregarious for no sieveful of mud yielded more than one specimen and generally repeated sievefuls at any spot failed to produce additional specimens. All of those taken were 5–10 inches below the surface of the mud; they were very inactive and were easily narcotized with Epsom salts and killed fully extended without difficulty.

PARACAUDINA TETRAPORA

Caudina tetrapora H. L. CLARK, 1914. Rec. W. A. Mus., **1**, p. 170.
Paracaudina tetrapora H. L. CLARK, 1935. Ann Mag. N. H., (10), **15**, p. 284.

This is apparently a common holothurian in shallow water near Fremantle, W. A., but I failed to secure any specimens during my visits to the region. The Western Australian Museum at Perth, however, has a considerable number of specimens collected at Cottesloe Beach, where they were washed up after stormy weather. There are 9 of these specimens before me, kindly loaned by the Museum. They are more or less white in color, the larger ones especially, and range in size from 65 mm. in length (of which the tail is 25 mm.) by 12 mm. in diameter, to 190 mm. in length, with no caudal portion evident, by 30 mm. in diameter. Naturally they are in very poor condition, much contracted, the body surface badly rubbed, and usually more or less eviscerated. But enough of the surface is still present to retain the spicules here and there so there is no doubt as to the identity of the specimens. Evidently *tetrapora* grows to a much larger size than any other member of the genus.

The South Australian Museum at Adelaide kindly loaned me two Paracaudinas taken near the Semaphore, on Le Fevre's Peninsula, S. A., which I hoped would prove to be *australis*. To my great surprise, they are typical examples of *tetrapora*, the geographical range of which is thus suddenly extended from the Abrolhos Islands and Cottesloe Beach, W. A. to St. Vincent Gulf, S. A. One of these South Australian specimens is an adult 70 mm. long by 25 in diameter, with most of the caudal region lacking. The other has the body 45 by 12 mm. and a slender caudal appendage about 30 mm. long and little more than 1.5 mm. in diameter distally. The larger specimen is nearly white, the smaller is pale gray.

Aphelodactyla delicata[1] sp. nov.

Length 52 mm.; diameter about 10 mm.; body tapers considerably to the rear end but there is no definite caudal portion. Tentacles 15, nearly 3 mm. long, about 1.5 mm. thick; in life with a minute terminal digit on each side, but in the more or less contracted preserved material, these digits are indistinct and often wanting, so that the tentacle may be quite finger-like or more often, truncate. In all the specimens except the smallest, the slightly contracted tentacles do not form a circle as usual but a straight double series, appressed over the mouth, seven on each side and a single one at one end. I have never noted such a disposition of the tentacles in any molpadiid before. Calcareous ring relatively stout and moderately high; there is a sharp anterior projection on each interradial piece, associated with a conspicuous antero-posterior ridge on the outer surface; radial pieces with two anterior points, two ridges and two short, thick posterior projections. Body wall very thin and delicate with widely scattered calcareous particles, most abundant near the posterior end. These particles are in the form of delicate perforated plates ranging from 25 to 80μ in diameter; the smaller ones (fig. 59b) are flat and have only 3–6 perforations but the fully developed ones (fig. 59a) are slightly convex, and have 4 central holes, surrounded by 10 slightly smaller ones; all of the perforations have coarsely dentate margins. Color pale gray, the tentacles yellowish or brownish.

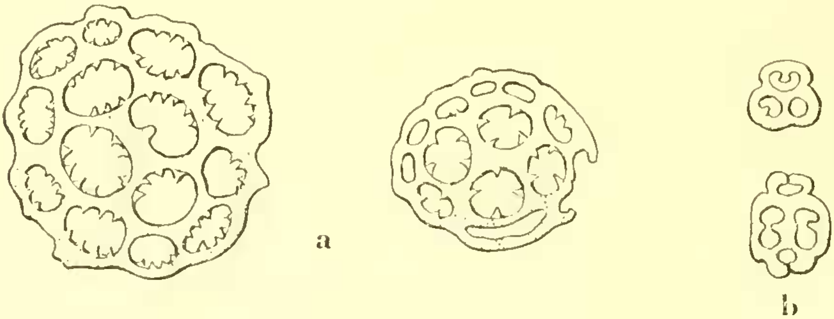

Fig. 59. Aphelodactyla delicata. Calcareous particles. x 425. a. Convex plates. b. Small flat plates.

Holotype, M. C. Z. no. 1675, and 10 paratypes from 5–8 fms. of water, in muddy sand, about five miles off shore between Cape Jaubert and Wallal, W. A., Sept. 1929. There is also one very small specimen taken off Lagrange Bay, on a similar bottom at the same depth, in June, 1932. Its 15 minute tentacles form a circle about the mouth and not an appressed series, but the few and very scattered calcareous particles show it to belong to this species.

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[1] *delicatus* = delicate, in reference to the texture of the body wall.

In 1912, Sluiter (Zool. Jahrb. Suppl. **15**, pp. 409–422) published a very careful revision of the genus Aphelodactyla in which he concluded that there is but a single species known, *molpadioides* (Semper), altho no less than eight names have been given to different examples of it from various localities in the East Indian region. Dr. Deichmann, who has examined Sluiter's material in Amsterdam, agrees with his conclusions. Nevertheless the present species seems to be quite distinct, owing to the very characteristic perforated plates; the calcareous ring also seems to be different from that of the East Indian species. It is of course possible that *delicata* is only the young of the following species, but that is only an assumption for which at present there is no evidence. If specimens of intermediate size show that the perforated plates of *delicata* are a youthful feature which disappears with maturity, then it may be demonstrated that these little Aphelodactylas are the young of *leucoprocta*. Until such evidence is forthcoming, it seems best to treat them as a distinct species.

APHELODACTYLA LEUCOPROCTA[1] sp. nov.

Length 140 mm.; diameter about 40 mm. near middle of body, which tapers slightly to the blunt posterior end. Tentacles 15, strongly contracted and wrinkled, so that the presence of digits cannot be determined, but in life the tentacles were several millimeters long, truncate and slightly notched at the tip, with a blunt, rounded digit on each side; these digits are however so short, it would be no great error to call them wanting. Calcareous ring about 8 mm. high and quite stout; the anterior projections are a millimeter long, while the posterior pair on the radial pieces are fully twice as much. Body wall thick and muscular; in life, very smooth and slimy. Cloacal papillae present in clusters of 7–9 in each radius, the median terminal one largest. Calcareous particles present posteriorly, but not abundant, of three sorts; a very few relatively large doughnut-shaped bodies (fig. 60a), similar particles being found in *A. molpadioides*; short, irregularly branched particles, with wide, blunt branches (fig. 60b) not nearly as long or narrow as in the similar particles of *molpadioides*; small oval plates, about 40 x 30μ with 3 or 4 perforations (fig. 60c), quite unlike anything found in

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[1] λευκός = *white* + πρωκτός = *anus*, in reference to the conspicuous white periproctal region.

molpadioides. No plates, either perforated or not, with sharp projections, such as Sluiter figures as occurring in some specimens of *molpadioides,* have been found in the Australian material. Color in life dull purplish-brown or deep purple, the oral disk somewhat lighter; the lining of the cloaca and more or less of the body surface adjoining it, conspicuously white; the purple pigment seems to be located in the slimy epidermis, which rubs off very easily, leaving gray patches. In the preserved material, the two paratypes still show much of the dark epidermis, but the holotype, which was not so dark in life, is now a light brown, becoming even lighter, almost a dirty white, on the ventral surface; the cloacal lining and margin are distinctly white.

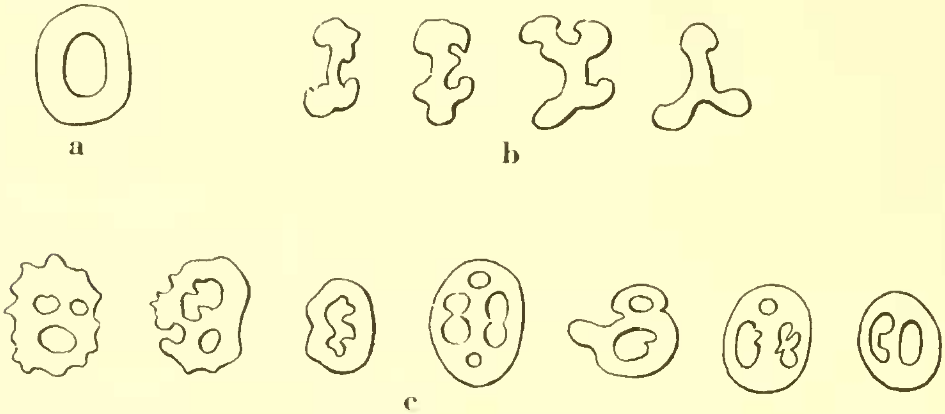

Fig. 60. Aphelodactyla leucoprocta. Calcareous particles. x 425. a. Doughnut-shaped bodies. b. Branched particles. c. Small oval plates.

Holotype, M. C. Z. no. 1679, and 2 paratypes from widely separated localities near Broome, W. A. The holotype was dug out of the sandy mud near the jetty, when digging for Paracaudinas July 2, 1932; it was about 150 mm. long and 50 mm. in diameter. One of the paratypes, about 100 mm. long when living, was found, projecting from the sandy bottom, more or less covered with sponges and algae, at low water mark, on the south side of False Cape Bossut, Sept. 9, 1929. The other paratype, which measured 125 by 40 mm., was dredged June 11, 1932, northeast of Cape Vilaret, in 7 or 8 fms. of water on a bottom of sandy mud; several hundred heart-urchins (Breynia) came up in the dredge with it.

In view of the remarkable diversity shown by the fifty specimens of *A. molpadioides* examined by Sluiter, I have hesitated to recognize these specimens from northwestern Australia as a distinct species, but they agree so well with each other and show such constant differences from any of Sluiter's specimens that I believe it is best to do so. In life, they are the slimiest and most completely inert holothurians I have ever handled. They are very responsive to the action of Epsom salts and relaxed readily, so that it was easy to kill them fully extended, tho the tentacles contracted considerably.

SYNAPTIDAE

CHONDROCLOEA RECTA

Plate **15**, figs. 5 and 6

Synapta recta SEMPER, 1868. Holothurien, p. 14.
Chondrocloea recta ÖSTERGREN, 1898. Öfv. K. Vet.-Akad. Forh., **55**, p. 114.

This is the common synaptid of the northern coast of Australia, occurring in Torres Strait and at Darwin and Broome. In my experience, it is usually associated with sponges, and dozens of specimens may be taken from a single large sponge. It sometimes occurs under stones near low water mark but it is much more abundant in 5–10 fathoms of water. The diversity of color is so great as to bewilder one who seeks to assort his material on that basis. My field notes made at Darwin show *five* supposed "species" of synaptids taken, as follows:

No. 5. "Light dull brownish-yellow mottled with light purplish-brown; tentacles dull purplish, much darker than body."
No. 6. "Uniform dull translucent purple, tentacles, at least terminal portion, much darker."
No. 12. "Notable for white color with 5 longitudinal stripes (dull purple, brown or deep reddish). Tentacles pure white."
No. 13. "Bright red orange or vermilion."
No. 14. "Clear translucent white, with only a few spots of purplish here and there anteriorly, especially on tentacles."

The preserved material still shows much diversity of color, but examination of tentacles, calcareous ring and calcareous particles shows a uniformity which compels me to call them all the same species. Apparently the diversity of coloration depends on the extent to which the miliary granules and the pigments are developed. Furthermore the pigment may be either violet (becoming brown or very deep purple) or light red (becoming orange or deep carmine). The pattern of coloration is often, but by no means always, longitudinal. The field notes made in Broome, in 1929, indicate three "species" but on August 15, a very large number of specimens were collected from sponges brought up by a diver, and I became very doubtful about the validity of my supposed "species." In 1932 I was again misled by color and size diversity and indicated no fewer than four "species" in my notes. This material from Broome has strengthened my conviction, very unwillingly, that all the specimens under discussion must be referred to *recta* and that it is futile to try to distinguish the color forms by names. Types of coloration, whether mottled, banded, striped, spotted or unicolor may furnish a better character than the actual colors themselves. Heding in his valuable paper on the Synaptidae (1928) holds that in the material of Synaptula (including Chondrocloea) which he studied, "the larger part of the specimens have a rather characteristic colour and even the irregularly mottled species as *recta*, *striata*, *psara* and *denticulata* may be separated by the coloration." Since I have been led to the conclusion that color is an unreliable character in itself and must be used with great caution in distinguishing species, it is not strange that I find Heding's treatment of the genus unsatisfactory and his key unusable. I do agree with him, however, in thinking it would be better to separate the single West Indian form, *hydriformis*, from the Indo-Pacific species, from which it is quite obviously different; and this necessitates using Östergren's name Chondrocloea for the latter group, since Synaptula was proposed by Örsted for the West Indian species alone. As Heding has pointed out, the type of Chondrocloea is *Synapta indivisa* Semper, which is a very dubious form. I have no doubt it is simply the young of *recta*, and hence *recta* would be the genotype of Chondrocloea. This would be satisfactory but as long as *indivisa* is maintained as a distinct species, it must be called the genotype.

Besides its diversity in color, my Australian material is of interest because of its range in size. As preserved the smallest specimen is only 15 mm. long, the largest is 350; in life, the larger specimens were naturally some ten per cent longer (or more), the smaller ones probably at least twenty per cent. All of the specimens examined have 13 tentacles, and agree in the essential anatomical characters and in the calcareous particles. The very moderate diversity in the anchors and plates is notable, but there is considerable diversity in the eye-spots, which are often distinct but often are faint and sometimes very hard to make out at all.

There are 14 specimens from Darwin, all dredged near the Shell Islands, and 153 specimens from Broome and southwestward to False Cape Bossut.

CHONDROCLOEA MACRA[1] sp. nov.

Length, in life about 425 mm. with a diameter of 10 mm.; preserved, the single specimen is 400 mm. long. Tentacles, 15, about 12 mm. long, with some 25 pairs of relatively short digits, which are not connected by a web except perhaps at the very base. Eye-spots on the oral disk small but very distinct. Calcareous ring noticeably reduced and completely imbedded in the conspicuous, wide, white cartilaginous ring. Polian vessels at least 8 (probably 10), long and slender. Madreporic canal single, small, imbedded in dorsal mesentery. Gonads numerous but not long or extensively branched. Ciliated funnels not peculiar, low, short and wide, very numerous. Calcareous particles like those of *recta* but the anchors and plates are distinctly larger than in that species; this difference cannot be given any weight, however, as it is undoubtedly due to the large size of the specimen under consideration. Color in alcohol mottled olive-green and light buff, with a narrow, dark brownish longitudinal line in each radius; massed miliary granules here and there form minute, whitish spots. My field notes say of this synaptid: "Variegated light and dark shades of bright greenish-brown, flecked with numerous spots of dirty cream-color, one surface (upper?) much more uniform than the other."

Holotype and only specimen, M. C. Z. No. 1689, from Allaru Island, Coburg Peninsula, Northern Territory, on eel-grass bottom in about two feet of water, at low tide.

In appearance and habitat this synaptid was so much like *Synapta maculata* I thought it might be a small example of that species, but the calcareous particles are unquestionable evidence that it is a Chondrocloea. At first I considered it an unusually large and peculiar specimen of *recta*, but I am now satisfied that it is really distinct from that species, the large size, the fifteen tentacles, the greatly developed cartilaginous ring, and the type of coloration serving to distinguish it readily from all the hundreds of specimens of that species which I have seen. It is true that except for the number of tentacles, half grown and young specimens might be difficult to distinguish in the Museum, but I believe, in life, the appearance and habitat would serve the purpose. The other species of Chondrocloea having 15 tentacles, are *nigra*, *reciprocans* and *rosea*. Heding holds that *nigra* is not a Chondrocloea — at any rate, its miliary granules are distinctive; *rosea* has a poorly developed cartilaginous ring and apparently a distinctive coloration; *reciprocans* is a small, dark-colored species from the Red Sea, to which it would seem absurd to refer this Allaru Island synaptid.

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[1] *μακρός* = *long*, in reference to its very considerable size as compared with *recta*.

In my paper on the Synaptinae of the M. C. Z. (1924, Bull. M. C. Z., **65**, no. 13, p. 476) I refer to a specimen from the Caroline Islands, which I considered a very large example of *recta* altho it had 14 tentacles. Re-examination of that specimen makes me believe it originally had 15 tentacles; the cartilaginous ring is very conspicuous, while the size and coloration (which is, however, obviously faded) are unlike any undoubted *recta* I have seen. I think, therefore, that this individual is best considered as another example of *macra*.

LEPTOSYNAPTA DOLABRIFERA

Synapta dolabrifera STIMPSON, 1855. Proc. Acad. Nat. Sci., **7**, p. 386.

Leptosynapta dolabrifera H. L. CLARK, 1908. Apod. Hol., pp. 23, 89. Heding, 1928, Vid. Med., **85**, pp. 221–224.

This is the characteristic synaptid of the southern coast of Australia and the present collections show that it extends to Lord Howe Island on the east and up the western coast of the continent, at least to Port Hedland and possibly to La Grange Bay. In Roebuck Bay, the following closely allied species (*dyscrita*) seems to replace it. In Torres Strait, a species, *latipatina*, based on a single headless specimen, represents it. So far as I know, no Leptosynapta has yet been taken on the Queensland coast. In habitat and general appearance in life, *dolabrifera* is very similar to the common Leptosynapta of European and American shores, *inhaerens* (and *tenuis*, if one considers the American form worthy of a separate name). All the specimens I have taken have been found in sand under rock fragments at or near low water mark. The largest individuals I have collected were less than 100 mm. long, even when extended, but Mortensen took much larger ones on a rocky shore in Port Jackson (Heding's *irregularis*). The color in life is normally white or cream color, sometimes quite yellowish; some Leptosynaptas in my collection were distinctly pink or reddish when taken and were considered a different species, but I cannot now so regard them. Preserved specimens are white or yellow, or occasionally grayish or even brown.

Heding (1928) reporting on Dr. Mortensen's collection of synaptids records four species of Leptosynapta from Port Jackson, New South Wales, and a fifth from Long Reef, which lies just north of North Head, Port Jackson. As my collection includes five specimens from Long Reef, six from Port Jackson and six from other points on the coast of New South Wales, I supposed I should find them to represent several of Heding's species. To my surprise, I am obliged to call them all *dolabrifera* and the situation became more and more perplexing as I examined my material from Lord Howe Island, from Tasmania, from South Australia, from half a dozen places on the coast of southern Western Australia, and finally from Port Hedland on the northwest coast. I do not mean to assert that all these dozens of specimens are exactly alike — by no means. They differ greatly in size, color, form, number of digits on the tentacles, calcareous ring and in the anchors, plates and rods. But I cannot find any correlation between these differences; many are certainly associated with age or size, others are merely individual diversity, and none, so far as I can see, are connected with locality. I cannot avoid the feeling that Heding's species are not real but are the result of giving undue weight to individual diversity. This feeling is confirmed as one studies his key to the species of Leptosynapta and his figures of the calcareous particles and the calcareous ring. I suppose there is no *a priori* reason why there may not be four or more species of Leptosynapta found in Port Jackson but in my judgment, Heding's *reducta* is based on specimens of *dolabrifera* not yet full-grown, *variopatina* and *jacksoni* are quite inseparable from *dolabrifera*, and *irregularis* is based on fully grown and more or less senescent individuals of the same species. They were taken at the same time and place as typical *dolabrifera*.

The material in my collection is, as already stated, quite as varied as Heding's but I am unable to segregate it into definable groups. None of the specimens is nearly as large as the specimens which Heding calls *irregularis*; my largest are not more than 85 mm. but they are 8 mm. in diameter and lack the anterior end and hence were probably well over 100 mm. in life. They were taken by Professor T. T. Flynn in Ralphs Bay, Tasmania, in 25 fms. of water. Some others deserve a word of comment. Those from Lord Howe Island, where they are fairly common but not abundant, are all small, not often over 50 mm. long and in life were translucent white, now and then yellowish, but never pink or reddish. A specimen of average size taken at Shell Harbor, N. S. W., May 4, 1932, was pure white and has 14 tentacles. A specimen collected at Port Willunga, S. A., Nov. 2, 1929, was listed in my field notes as a "red synaptid" in contrast to three white ones, and I had no doubt at the time that it was a different species. But the calcareous particles are not peculiar and as it lacks the tentacles and is badly contracted, it is impossible to identify it satisfactorily; it is now 45 mm. long by 5 mm. in diameter and is dull purplish in color, with one surface (the lower?) much lighter than the other. At Bunkers Bay, W. A., Prof. E. W. Bennett collected four synaptids, three of which are ordinary *dolabrifera* but one is distinctly pink and was supposed, when collected, to be a different species from the others. The calcareous particles, however, are not peculiar. These reddish synaptids of the southern coast of the continent deserve further study, for their occurrence with, and resemblance to, *dolabrifera* remind one of the occurrence together of *roseola* and *inhaerens* (or *tenuis*, if you please) on the eastern coast of the United States. At Rottnest Island, W. A., a small and slender Leptosynapta is common but the largest taken was only about 60 mm. long; I cannot distinguish them from those taken at Lord Howe Island. Four specimens in the Museum at Perth, supposed to be from Western Australia, but with no definite locality, are notable for the very small miliary granules or rods in the body wall. It is possible that these may prove to be a distinct local form, but more likely they will be found to intergrade with typical *dolabrifera*. The four specimens which I collected at Port Hedland July 6, 1932, are small but in excellent condition and I can find no reason for calling them anything but *dolabrifera*. Their habitat and appearance in life was exactly similar to that of the Leptosynaptas at Lord Howe Island. Finally, a small synaptid found under a stone at False Cape Bossut September 11, 1929, proves to be a Leptosynapta like *dolabrifera* but it lacks the anterior end; the calcareous particles are not typical but are so much like those of the common Australian species that it would be foolish to base a new name on them.

The collection at hand contains 143 specimens, which I consider should be called *dolabrifera*, at least for the present; as already stated, certain individuals are dubious.

Lord Howe Island: Reef-flat near Mt. Lidgbird, 25 specimens.
Neds Beach, 25.
New South Wales: Collaroy, Long Reef, 5.
Port Jackson, Bottle and Glass Rocks, 6.
Port Hacking, Gunnamatta Bay, 5.
Shell Harbor, 1.
Tasmania: Ralphs Bay, 8.
Hobart, 1.
South Australia: Port Willunga, 4.
Western Australia: Bunker's Bay, 4.
Bunbury, 4.
Point Peron, 3.
Rockingham, 1.
Rottnest Island, 42.
Port Hedland, 4.
Locality unknown, 4.
False Cape Bossut, 1.

Leptosynapta dyscrita[1] sp. nov.

Length 57 mm., with a diameter of about 3 mm. Tentacles 12, with about 6 pairs of pinnules developed and 2 or 3 more indicated; on the inner surface of each tentacle is a group of 3–12 sensory cups. Calcareous ring not peculiar, the radial pieces perforated for the passage of the nerves. Internal anatomy as in *dolabrifera*. Anchors and plates as in *dolabrifera* but the small particles of the longitudinal muscles and tentacles fairly distinctive. In the muscles, these are stout bodies (fig. 61a) sometimes a little curved but usually short and straight, with thick, rounded ends; often they are oval, ellipsoidal or nearly spherical; they are never branched nor do they show projections of any kind; the length is very rarely as much as 35μ and is commonly about 25, while the width ranges from 20–90 per cent of the length. In the stalks of the tentacles are similar particles (fig. 61b) but they are smaller and somewhat more slender. In the digits, they appear as slender curved rods (fig. 61c) enlarged and notched at each end. Color in life translucent white, but in alcohol dull and opaque; tentacles pure white.

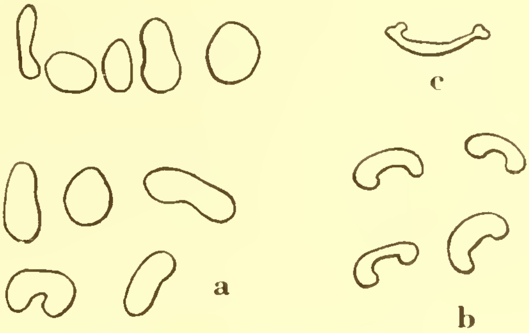

Fig. 61. Leptosynapta dyscrita. Calcareous particles. x 425. a. From longitudinal muscles. b. From stalks of tentacles. c. From digits.

Holotype, M. C. Z. No. 1717, from Broome, Roebuck Bay, Western Australia, in sandy mud, exposed at very low tides.

Besides the holotype, which is the largest specimen taken, there are 13 paratypes, all from the teeming bottom of the harbor at Broome. They were collected at low tide by sifting the sandy mud in a sieve, and were found in company with Protankyra, Paracaudina and several species of ophiurans. The appearance in life is like that of small specimens of *dolabrifera* and they are undoubtedly a local form of that species, apparently sufficiently differentiated to warrant giving them a name of their own, in view of their geographical isolation.

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[1] δύσκριτος = *hard to determine, doubtful,* in reference to its close relationship to *dolabifera.*

PROTANKYRA VERRILLI

Plate **15**, fig. 4

Synapta verrilli Théel, 1886. "Challenger" Holothurians, p. 12.
Protankyra verrilli Östergren, 1898. Öfv. K. Vet.-Akad. Forh., **55**, p. 117.

This species was originally discovered by the "Challenger" in shallow water, in Torres Strait, and so far as I know has not been taken since. It is not represented in Dr. Mortensen's large collection of synaptids, which contained nine species of Protankyra (Heding, 1928). But at Broome and along the coast to the southwest at least as far as Eighty Mile Beach, a Protankyra is common, which seems to me identical with the Torres Strait form. Most of these specimens were dug from the firm mud-sand bottom of Roebuck Bay, near the jetty at Broome, at low tide. The color in life is milk white with widely scattered spots of deep crimson, especially at the anterior end; the number of these spots differed much in different individuals. The largest specimens were 100–150 mm. long and 8–10 mm. in diameter, but most of those taken were much smaller. A young specimen dredged off Eighty Mile Beach in three fathoms on a muddy bottom was colorless and almost transparent in life.

Théel had but two specimens on which to base his description of *verrilli*, and the larger was only 23 mm. long. Obviously these were very young individuals, the small size and incomplete nature of the anchor-plates, as shown by Théel's figure, confirming this opinion. In the smallest specimens examined by me (less than 25 mm. long) the plates are, as a rule, complete and show more perforations than in Théel's figure. In my largest specimens the plates are 375μ long and have scores of dentate perforations. Comparison of small and large specimens has convinced me that all belong to one species and are identical with the "Challenger" material. There are 57 specimens before me which I refer to *verrilli*, of which 41 are from the harbor at Broome, 15 from off False Cape Bossut, in 3 fms., on sandy mud, and one very young individual is from off the northern end of Eighty Mile Beach, in 5 fms. on a muddy bottom.

PROTANKYRA BISPERFORATA[1] sp. nov.

Length 130 mm., diameter 5–6 mm. Tentacles 12 (in the holotype there are 13), each with two pairs of long slender digits at the tip and a number of sensory-cups on each side of the inner surface near base of stalk. Calcareous ring rather stout but low, with the posterior margin of all the segments slightly concave. Polian vessels 3, long and slender. Calcareous particles numerous and distinctive; anchors in anterior part of body (fig. 62a), small (125–130μ) with stout arms but little curved and with only 2 or 3 teeth on outer edge near tip; they are accompanied by plates (fig. 62b) of nearly the same length whose width is about two-thirds as much; these plates have two large perforations lying side by side, somewhat nearer the anterior than the posterior end; in front of this pair are half a dozen or more nearly circular holes, and posterior to them are 8–10, large, and 20–30 or more small holes; the margins of all the perforations are perfectly smooth. In posterior portion of body, particularly near the end, the anchors and plates are much larger and very different in form; anchors (fig. 62c) up to 300μ in length with plates (fig. 62d) about 180–190μ long, and 100 wide; arms of anchors strongly curved, about one-fourth the length of shaft, with 6–8 well developed teeth on the outer margin of each; in fully developed anchors there are similar teeth on or near the vertex of the anchor, a very unusual feature. Besides anchors and plates the body wall contains more or less numerous but well scattered, small perforated plates with irregular margins (fig. 62e) 30–50μ in diameter; the larger of these plates may have slight elevations or knobs here and there on the surface but the majority are quite smooth; the number of perforations ranges from 2 to 14. In the longitudinal muscles, and in the skin over them, are numerous perfectly smooth granules (fig. 62f) about 20μ long or less. Color in life, translucent flesh pink; on being placed in alcohol, they become quite red and opaque, but the red fades and the preserved specimens are dingy whitish or pale brown.

Holotype, M. C. Z., No. 1719, from the jetty flat at Broome, Western Australia, low water mark.

Besides the holotype, which is the largest specimen taken there are 20 paratypes of diverse sizes, the smallest about 40 mm. x 3. Most of the specimens are more or less fragmentary, as the animals, especially the larger ones, have a tendency to constrict off the posterior part of the body either in the sieve when collected or subsequently when being preserved. All the paratypes have 12 tentacles, so that the additional tentacle of the holotype is exceptional. On the other hand, the holotype is the only adult specimen which is undoubtedly complete, a most important point where the difference between the anchors and plates of the two ends of the animal is as great as in this species.

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[1] *bisperforatus* = twice perforated, in reference to the conspicuous pair of large perforations in the anchor-plates.

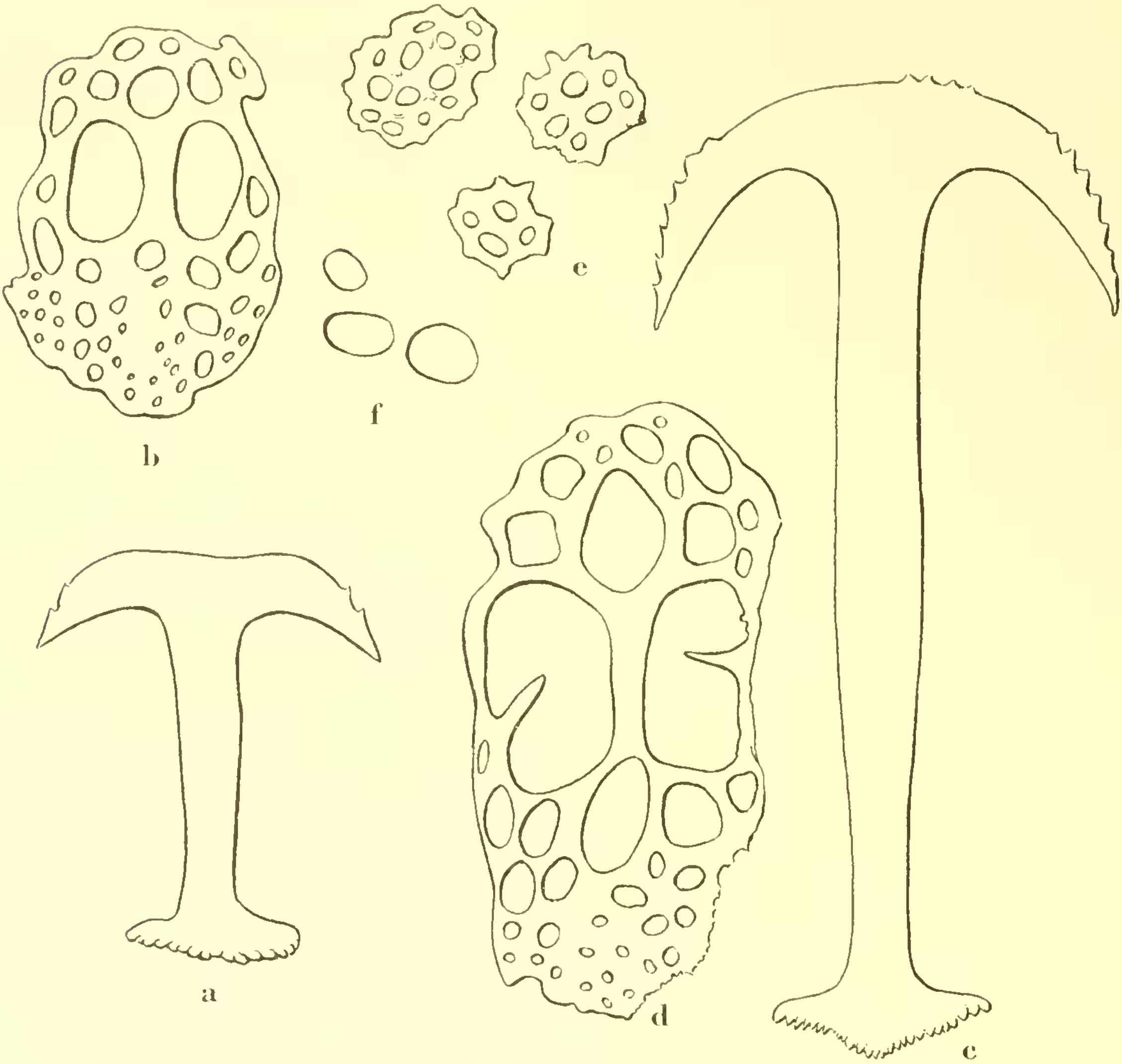


Fig. 62. Protankyra bisperforata. Calcareous particles. x 425. a. Small anterior anchor. b. Small anterior plates. c. Large posterior anchor. d. Large posterior plate. e. Small perforated plates. f. Smooth granules.

There is some diversity in the number of calcareous particles in different individuals and in different parts of the same specimen. As a rule the particles of all kinds are more abundant in larger specimens, and at the anterior end. The large anchors and plates occur only near the posterior end of the animal and hence are wanting in many fragmentary specimens. Only the largest and most fully developed anchors have teeth on the vertex.

It is a curious fact that the anchor-plates of this Australian Protankyra are surprisingly like those of *P. duodactyla*, from deep water (1000–1777 m.) off the coast of western North America and the Aleutian Islands; in other particulars, however, the two species are quite unlike. The accessory particles of *bisperforata* are similar to those found near the anterior end of the body in *P. pseudo-digitata* but the anchor-plates are utterly unlike those of that species. Probably the nearest relation of *bisperforata* is the New Zealand species *uncinata* (Hutton) which it resembles in many ways, but the anchors and anchor-plates are obviously different. No asymmetrical anchors have been seen in the Australian species. On the whole this synaptid from Broome, which occurs with *P. verrilli* but is much smaller and quite different in appearance, is a very well characterized new species.

CHIRIDOTA GIGAS

DENDY and HINDLE, 1907. Jour. Linn. Soc.: Zool., **30**, p. 110, (as "Chirodota").

Among the echinoderms so generously given me by Professor T. T. Flynn at Hobart, in 1929, I find three Chiridotas which are evidently representatives of this New Zealand species. The largest now measures about 100 mm. long by 8 mm. thick, a second is only a trifle less, but the third is considerably smaller. The color of the large specimens is now dull purplish-brown, but the little one is very much darker. There is no trace of red in any one of the three to indicate the scarlet color which characterizes the living animal. These Tasmanian specimens were taken at Wyngard, on the northeast coast of the island, in 1927. Joshua (1914, Proc. Roy. Soc. Victoria, 27, p. 7) gives an excellent account of this species as it occurs at Torquay, Wilson's Promontory, Victoria.

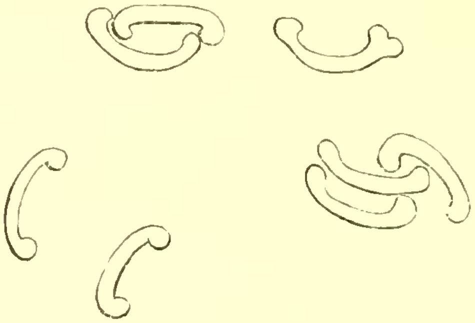
CHIRIDOTA RIGIDA

SEMPER, 1868. Holothurien, p. 18 (as "Chirodota").

At Lord Howe Island, a small Chiridota is fairly common, which I cannot distinguish from Semper's widely distributed species. The largest specimens were scarcely 50 mm. long in life and now measure 38 x 4 mm. When living they were very bright red with white tentacles and numerous white wheel-papillae. In alcohol, the red color leaches out almost completely (at first, quite rapidly) so that the preserved specimens are a dingy reddish white, but some individuals retain more of the reddish tinge than do others. These little synaptids live in the sand under rock fragments near low water mark. We found them both at Neds Beach and on the reef-flat near Mr. Lidgbird, securing 40 specimens altogether.

Chiridota magna[1] sp. nov.

Length of fragment 47 mm.; diameter near larger end, 13 mm. Anterior end with tentacles, calcareous ring, etc., wanting. Wheels present in a very few large papillae, occurring in two interradii. Body wall with numerous well scattered bracket-shaped bodies (fig. 63) having the ends thickened, usually a bit enlarged, and very rarely notched as though to become bifurcate; these brackets are 30-40μ in length. Color of fragment yellowish-white to pale brown; longitudinal muscles brown.



Figs. 63. Chiridota magna. Bracket-shaped bodies. x 425.

Holotype and only specimen, Australian Museum, No. J5985 from off Sow and Pigs Reef, Port Jackson, New South Wales, in 6 fms.

This Chiridota is quite unlike any of the other Australasian species, in the character of the calcareous particles in the skin. It recalls Müller's species *violacea* from Mozambique but in that species the brackets are said to be like those figured by Valentine from Echinus, which have pointed tips, and the wheel papillae are said to occur in all the interradii; moreover the color of *violacea* is presumably quite different from the Port Jackson specimen. Of course, until a complete individual is available we cannot even be sure that this new species is a true Chiridota, but it seems obvious that it is a previously undescribed synaptid.

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[1] *magnus* = large, in reference to the unusual size.

Taeniogyrus australianus

Chirodota australiana Stimpson, 1855. Proc. Acad. Nat. Sci. Philadelphia, **7**, p. 386.
Taeniogyrus australianus Semper, 1868. Holothurien, p. 23.

While collecting at Bottle and Glass Rocks in Port Jackson, November 27, 1929, we took a number of synaptids from sand beneath rocks near low water mark. As the larger ones were evidently Leptosynaptas, it was supposed at the time that all were. Careful examination, however, shows that the two smallest are really young individuals of this characteristic Port Jackson species. One is only 15 mm. long and less than 2 mm. in diameter. The other is simply the anterior end of a considerably larger specimen.

Taeniogyrus cidaridis

Ohshima, 1914. Synaptidae of Japan, p. 477, (*nomen nudum*), 1915. Proc. U. S. Nat. Mus., **48**, p. 286. Heding, 1928, Vid. Med., **85**, p. 316.

A little synaptid, about 22 mm. long, taken at Rottnest Island, Western Australia, in January 1931 by G. Bourne, is unquestionably a Taeniogyrus, and a close examination has failed to show any satisfactory difference between it and Ohshima's Japanese species. To add to my perplexity, Heding has described a species, *T. keiensis*, taken by Dr. Mortensen in 400 m. at the Kei Islands, which he says is "most closely related to *T. cidaridis*." The Rottnest Island specimen's sigmoid bodies are more like those of *cidaridis* as figured by Heding than they are like those of *keiensis*. I cannot avoid the feeling that the absence of any real distinction between the two species could be demonstrated if only enough material were available to indicate the amount of individual diversity.

Trochodota allani

Taeniogyrus allani Joshua, 1912. Proc. Roy. Soc. Vict., **25**, p. 79.
Trochodota allani Joshua, 1914. Proc. Roy. Soc., Vict., **27**, p. 8.

A single synaptid dredged in the estuary of the Derwent, below Hobart, Tasmania, Nov. 15, 1929, proves to be of this species. It is nearly 30 mm. long and of a pale gray color. My field notes, made at the time the specimen was taken, say "no particular color; no speckles; a queer thing." Joshua says the color in life is blood red. In spite of this difference in color, the Tasmanian specimen agrees well in other respects with specimens from Victoria.

TROCHODOTA ROEBUCKI

JOSHUA, 1914. Proc. Roy. Soc. Vict., **27**, p. 9.

While collecting along the shore near low water mark at Geraldton, W. A., October 7, 1929, I found under rock fragments 5 small synaptids, 14–50 mm. long, of a pinkish color, which I took to be Leptosynaptas. Nearly two weeks later, at Rottnest Island, Oct. 12, we took 9 similar specimens, but all very small and slender, from under rocks in shallow water. The Geraldton specimens, in alcohol, are still light colored but the Rottnest specimens are quite red. I have compared this material with material sent by Mr. Joshua from the Victorian coast and it is apparently identical. It is of course interesting to find that this Victorian species ranges so far to the west and north as Rottnest Island and Geraldton.

LOCAL LISTS

In the following pages will be found lists of the species of echinoderms from each of the different areas we visited in 1929 and in 1932, and from several additional areas which have provided much material but chiefly as gifts or loans. These local lists throw some light on the distribution of the various species but their chief value lies in showing what species may be expected at any given point by the visiting zoologist or collector. The lists for Lord Howe Island and for Broome are the result of sufficient collecting to justify the belief that they contain a very large percentage of the local echinoderms. Those for Darwin and for Western Australia are much less complete, while the remaining 6 are only imperfect indicators of what the complete local list may be. They will serve however as starting points for the compiling of complete local lists. As the names used are those of the present volume, the authority for each name is omitted.

I. LORD HOWE ISLAND

The following list contains not only the speciès which we collected in our three weeks at the Island, March 31–April 22, but several other species which are authenticated by specimens in the Australian Museum. (These are indicated by an asterisk.) It is therefore a complete list of the Echinoderms of Lord Howe so far as they are at present known. In the hope of making the list more useful to visitors to the Island, a few notes as to occurrence and abundance of each species are added.

In 1909, I published a revised list of the echinoderms then known from Lord Howe (See "Thetis" Rep., p. 520) which included 18 species. All of these are in the following list but a few now bear a different name:

Ophidiaster germani is now listed as *O. confertus*
Henricia heteractis is now *Nepanthia belcheri*
Ophiocoma scolopendrina is undoubtedly *O. insularia variegata.*
Holothuria fuscocinera is no doubt *H. pardalis.*
Holothuria maclcari is most probably *H. monocaria*
Cucumaria sp.? is probably based on a very young *Holothuria arenicola* (See p. 517)

The following list contains the names of 58 species. This large increase in the number of echinoderms known from Lord Howe is due to the very great assistance given me at the island (See antea, p. 8) in our persistent search. Mr. Kirby gave us the use of his motor-boat for dredging in the lagoon but animal life there during April was apparently very scanty. Outside the reef, the sea was too persistently rough for dredging from so small a boat. As a consequence nearly all our collecting was done along shore but Mr. Baxter, whose knowledge of the local marine fauna was of the greatest service, was indefatigable in helping us to find novelties.

The sea-swept reef on the western side of the island which protects the big lagoon proved a very poor hunting ground even when a quiet sea and low water permitted us to work there, but where it adjoins the mountains it develops an extensive reef-flat which makes an excellent hunting ground. Experience soon taught us however that the small lagoon at Neds Beach, well sheltered from the southwest winds and seas, was the best place for our search, and its accessibility was an added point in its favor. Hence the bulk of our collections came from that relatively small area.

Crinoids

Comanthus trichoptera — common among the living corals in the lagoon at Neds Beach.

Asteroids

Luidia australiae — occurs in the lagoon on the west side of the island but is not common.
Linckia guildingii — apparently rare, but its occurrence is beyond question.
  laevigata — we did not meet with this species but Mr. Kirby reported having found one and Mr. Baxter has sent one to Mr. Livingstone at the Australian Museum.
Leiaster leachii — rare on the reef-flat near Mt. Lidgbird.
Ophidiaster confertus — common in suitable areas.
Asterina alba — common on under side of rocks on both sides of the island.
  anomala — common on under side of rocks.
  heteractis — only 4 specimens known.
  perplexa — known from a single specimen taken at Neds Beach.
Patiriella exigua — very common on west side of island; not found at Neds Beach.
Patiriella nigra — rare; one specimen taken at Neds Beach; few others known.
Nepanthia belcheri — common, but inconspicuous.
Coscinasterias calamaria — rather common but mostly of small size.
Astrostole insulare — not very common; easily confused with the preceding.

Ophiurans

Ophiomyxa australis — found in the coral at Neds Beach but by no means common.
Amphiura constricta — rather common in sand under stones.
Amphipholis squamata — not rare but very easily overlooked.
Amphistigma minuta — not rare in lagoon but so small it is not easily found.
Ophiactis resiliens — not rare at Neds Beach.
  savignyi — fairly common.
Placophiothrix albolineata — only a single specimen found; in coral at Neds Beach.
Placophiothrix trilineata — not common, in coral at Neds Beach.

Ophionereis hexactis — rare and easily overlooked.
Ophiocoma brevipes — not very common; but not rare at Neds Beach.
erinaceus — very common.
insularia var: *variegata* — very common.
parva — not uncommon.
pica — rare; occurs in coral at Neds Beach.
Ophioteichus parvispinum — only a single specimen found; in sand under a rock at Neds Beach.
Ophioplocus imbricatus — found on reef-flat near Mt. Lidgbird and also at Neds Beach, but not very common.

ECHINI

Prionocidaris australis — rather rare.
Centrechinus setosus — occurs at Neds Beach and also near Mt. Lidgbird.
Centrostephanus rodgersii — not very common on the reef-flats.
**Salmacis sphaeroides* — not seen by us but there are 2 specimens from Lord Howe in the Australian Museum.
Tripneustes gratilla — large adults, rare; young individuals under rocks, rather common.
Echinostrephus aciculatus — we found but one; there are a number from Lord Howe in the Australian Museum.
Heliocidaris tuberculata — very abundant.
Echinometra mathaei — very abundant.
**Heterocentrotus mammillatus* — not seen by us but there is a Lord Howe specimen in the Australian Museum taken at Neds Beach in 1924.
Clypeaster australasiae — rare, only a few specimens known.
Echinoneus cyclostomus — common at Neds Beach but not easy to find.
Brissus carinatus — rare; 2 specimens from the reef-flat at Mt. Lidgbird.
Breynia australasiae — very abundant in the big lagoon.

HOLOTHURIANS

Psolus minutus — not rare on under side of rocks but easily overlooked.
Stichopus variegatus — rather rare; lagoon at Neds Beach.
Holothuria arenicola — not rare at Neds Beach.
atra — common and often large.
difficilis — very common.
homoea — a dubious species known only from a single specimen taken at Neds Beach.
leucospilota — not very common.
moebii — only one specimen taken.
monocaria — not uncommon at Neds Beach.
pardalis — common.
pervicax — not common.
scabra — we took one specimen on the reef-flat near Mt. Lidgbird.
Leptosynapta dolabrifera — not very common and all very small.
Chiridota rigida — not uncommon both at Neds Beach and on the Mt. Lidgbird reef-flat.

II. NEW SOUTH WALES

The rich echinoderm fauna of New South Wales is very inadequately represented in the following list which is based very largely upon my delightful collecting excursions with members of the Australian Museum staff to Gunnamatta Bay, Port Jackson near Middle Head (dredging) and Long Reef, Colloroy, and with Mr. Melbourne Ward to Bottle and Glass Rocks and to Shell Harbor. A few additional species, chiefly from deep water outside "The Heads," loaned by the Australian Museum, are also included.

Crinoids

Comanthus trichoptera
Austrometra thetidis
Compsometra loveni

Asteroids

Astropecten polyacanthus
    rappa
Anthenea acuta
Asterina inopinata
Paranepanthia praetermissa
Patiriella calcar
Patiriella exigua
    gunnii
Nepanthia belcheri
Coscinasterias calamaria
Allostichaster polyplax
Uniophora granifera

Ophiurans

Ophiomyxa australis
Ophiacantha heterotyla
Amphiura catephes
    constricta
    dolia
    magnisquama
    multiremula
Ophiocentrus fragilis
    pilosus
Amphipholis squamata
Ophiactis profundi var.
        novae-zelandiae
    resiliens
    savignyi
Ophiothrix acestra
    caespitosa
Macrophiothrix lampra
Placophiothrix aristulata
    spongicola
Ophionereis schayeri
Ophiocoma canaliculata
    pulchra
Ophiarachnella ramsayi
Ophiomisidium flabellum
Haplophiura gymnopora
Amphiophiura ctenophora
Ophiura kinbergi
    oöplax

Echini

Phyllacanthus parvispinus
Centrostephanus rodgersii
Holopneustes pycnotilus
Heliocidaris erythrogramma

Holothurians

Urodemas perspicillum
Psolidium nigrescens
Leptosynapta dolabrifera
Chiridota magna
Taeniogyrus australianus

III. QUEENSLAND

The following list consists of the species which have been sent to me by Mr. Melbourne Ward or loaned by the Australian or Queensland Museums. They are chiefly from Lindeman Island and Port Curtis. Obviously only a small percentage of the rich echinoderm fauna of Queensland is represented, though there are 92 species in the list.

CRINOIDS

- *Comatula pectinata*
- *Comantheria perplexum*
- *Comanthus parvicirra*
- *Comanthus timorensis*
- *Zygometra elegans*
- *Heterometra crenulata*
- *Dorometra parvicirra*

ASTEROIDS

- *Astropecten vappa*
- *Archaster typicus*
- *Goniodiscaster coppingeri*
  - *integer*
- *Iconaster longimanum*
- *Stellaster incei*
- *Anthenea acanthodes*
  - *acuta*
  - *crassa*
- *Anthenea sibogae*
  - *viguieri*
- *Pentaceraster australis*
- *Nardoa pauciforis*
- *Ophidiaster armatus*
- *Tamaria fusca*
  - *megaloplax*
- *Nepanthia brevis*
- *Retaster insignis*

OPHIURANS

- *Astrobrachion adhaerens*
- *Euryale aspera*
- *Astrocladus granulatus*
- *Astrochalcis tuberculosus*
- *Ophiacantha ameleta*
  - *discoidea*
  - *tenuispina*
- *Amphiura bidentata*
  - *constricta*
  - *diacritica*
  - *microsoma*
- *Ophiactis acosmeta*
  - *savignyi*
- *Ophiothrix aecestra*
  - *exigua*
- *Macrophiothrix longipeda*
- *Macrophiothrix megapoma*
- *Ophiotrichoides irregularis*
  - *martensi australis*
- *Placophiothrix striolata*
  - *trilineata*
- *Ophiopteron elegans*
- *Ophiogymna elegans*
  - *lineata*
- *Ophionereis semoni*
  - *tigris*
- *Ophiarthrum pictum*
- *Ophiarachna megacantha*
- *Pectinura yoldii*
- *Ophiochasma stellatum*
- *Ophiarachnella similis*
  - *paucigranula*
- *Ophioteichus multispinum*

ECHINI

Asthenosoma intermedium
Temnopleurus toreumaticus
Salmacis belli
    sphaeroides
Temnotrema decorum
    siamense
Nudechinus darnleyensis
Arachnoides placenta
Laganum depressum
Laganum laganum
Peronella lesueuri
    peronii
Echinoneus cyclostomus
Moira stygia
Brissopsis luzonica
Rhynobrissus hemiasteroides
Maretia ovata
Lovenia elongata
Breynia australasiae

HOLOTHURIANS

Pentacta australis
    coerulea
Pentathyone mirabilis
Thyone buccalis
Pseudocucumis africanus
Urodemas schmeltzii
Stichopus variegatus
Labidodemas semperianum
Holothuria arenicola
    difficilis
    edulis
    modesta
    monocaria
    pardalis
    scabra

IV. NORTHERN TERRITORY

Most of the 69 species in the following list were taken by us at Darwin or Quail Island in 1929, or at Darwin or on the Coburg Peninsula in 1932, but a few were loaned by the Australian Museum. It is not at all probable that it is anywhere nearly complete as a list of the echinoderm fauna of Darwin and vicinity. Not improbably collecting in spring or fall at the most favorable tides would yield many additional species. Nevertheless my visit to the Coburg Peninsula in 1932, confirmed the impression made by the six weeks spent at Darwin in 1929, that the marine fauna of the coast of the Northern Territory is not nearly so rich as that of the Queensland coast and cannot be compared with that of the northern coast of Western Australia. It seems to me that this is easily accounted for by the considerable amount of sediment in the water, in striking contrast to conditions at Mer (the northern end of the Great Barrier Reef) and at Broome. But the season of the year may be the really decisive factor for we were at Darwin in late fall and early winter (May-July) while my visit to Mer was in spring (September-October) and my first visit to Broome was in late winter (August, September). It is quite possible that the water is clearer and local conditions better at Darwin in September, for there was certainly more sediment in the water, and the collecting was distinctly poorer at Gantheaume Point, Broome, in June, 1932 than in September, 1929. Nevertheless I do not think there can be any question that the echinoderm fauna of the Northern Territory's coast is much less varied and abundant than is that of either Northern Queensland or the vicinity of Broome.

CRINOIDS

- *Comatula pectinata ?* juv. only.
- *Comanthina belli*
- *Comantheria briareus*
- *Comanthus timorensis*
- *Zygometra elegans*
- *Lamprometra gyges*
- *Petasometra variegata*
- *Dorometra parvicirra*

ASTEROIDS

- *Gymnanthenea globigera*
- *Anthenea mertoni*
    - *tuberculosa*
- *Asterina anomala*
    - *coronata fascicularis*
- *Nepanthia brevis*

OPHIURANS

- *Euryale aspera*
- *Ophiothauma heptactis*
- *Amphiura ambigua*
    - *constricta*
- *Ophiocentrus dilatatus*
- *Amphipholis squamata*
- *Amphiodia ochroleuca*
- *Amphioplus depressus*
    - *didymus*
    - *relictus*
    - *stenaspis*
- *Ophiactis brevis*
    - *fuscolineata*
    - *modesta*
    - *savignyi*
        - var *lutea*
- *Ophiothrix exigua*
- *Ophiothrix stelligera*
- *Lissophiothrix delicata*
- *Macrophiothrix belli*
    - *longipeda*
    - *scotia*
- *Ophiotrichoides martensi australis*
    - *smaragdina*
- *Placophiothrix melanosticta*
    - *plana*
- *Ophiothela hadra*
- *Ophionereis hexactis*
    - *semoni*
- *Ophiocoma parva*
- *Ophiurodon cinctum*
- *Ophiarachnella gorgonia*
    - *infernalis*
- *Ophioplocus imbricatus*

ECHINI

- *Phyllacanthus longispinus*
- *Temnotrema decorum*
- *Parasalenia gratiosa*
- *Arachnoides placenta*
- *Peronella lesueuri*
    - *orbicularis*
- *Breynia australasiae*

HOLOTHURIANS

- *Pentathyone mirabilis*
- *Thyone buccalis*
- *Pseudocucumis africanus*
- *Phyllophorus proteus*
- *Holothuria atra*
    - *conica*
    - *impatiens*
- *Holothuria leucospilota*
    - *monocaria*
    - *pardalis*
    - *scabra*
- *Chondrocloea macra*
    - *recta*
- *Molpadia altimensis*

V. AUGUSTUS AND CHAMPAGAY ISLANDS

Under this heading I am including the echinoderms collected by Captain Beresford E. Bardwell on his visit to Port George Mission in October, 1933. There are so many species which were not taken by us at Cape Leveque or in the vicinity of Broome that it would be quite wrong to include Captain Bardwell's prizes in my extensive list of species from Broome. There are only 38 species in the following list but 8 are not found in the Broome region (indicated by asterisks). One has not been taken elsewhere in Australia (double asterisks) and 2 are new to science (daggers).

ASTEROIDS

Astropecten hartmeyeri
†_Luidia hexactis_
Stellaster incei
Gymnanthenea globigera
Pseudoreaster obtusangulus
Asterina lutea
†_Nepanthia magnispina_
Protoreaster nodulosus
*_Culeita novaeguineae_

OPHIURANS

Macrophiothrix belli
*_Ophiarthrum elegans_
Ophiarachnella gorgonia
infernalis
*_Ophiarachnella septemspinosa_
Dictenophiura stellata
Ophiolepis unicolor
Ophioplocus imbricatus

ECHINI

Phyllacanthus longispinus
Prionocidaris bispinosa
*_Centrechinus setosus_
**_Mespilia globulus_ var. _pellocrica_
*_Parasalenia gratiosa_
*_Arachnoides placenta_
Peronella lesueuri
orbicularis
Echinolampas ovata
Hypselaster dolosus
Breynia australasiae

HOLOTHURIANS

*_Phyllophorus brocki_
proteus
Urodemas schmeltzii
Pseudocolochirus axiologus
Pentathyone mirabilis
Pentacta coerulea
Stichopus variegatus
*_Holothuria atra_
impatiens
ocellata

VI. THE BROOME REGION

Under this heading I am including all the numerous species which compose the rich fauna extending from Cape Leveque westward to and including Port Hedland. Probably the same fauna extends to Northwest Cape with little change or diminution, and some species range southward at least to Fremantle and Rottnest Island. But it is doubtful if any one point harbors a larger fauna than Roebuck Bay and nearly all of the species listed below probably occur there. The Torres Strait region has a known Echinoderm fauna of 246 species and varieties based on the collecting, including much dredging, of the "Challenger," the "Alert" and Dr. Richard Semon, in the vicinity of Cape York and Thursday Island, and the Carnegie Expedition to the Murray Islands in 1913. The Carnegie Expedition secured 182 species and varieties. The following list of the material taken in two visits to Broome includes 189 species and 6 varieties, a total of 195 forms, indicating that the Broome fauna is fully as rich as that of the Barrier Reef.

CRINOIDS

- *Comatella maculata*
- *Capillaster multiradiata*
- *Validia rotalaria*
- *Comatula pectinata*
    - forma *purpurea*
  - *solaris*
- *Comanthina belli*
- *Comantheria briareus*
- *Comanthus samoana*
  - *timorensis*
- *Zygometra comata*
- *Zygometra elegans*
  - *microdiscus*
- *Heterometra crenulata*
- *Amphimetra jaquinoti*
- *Lamprometra gyges*
- *Petasometra brevicirra*
- *Oligometrides adeonae*
- *Monilimetra bicolor*
  - *lepta*
  - *nomima*
  - *poecila*

ASTEROIDS

- *Astropecten granulatus*
  - *hartmeyeri*
  - *monacanthus*
  - *pulcherrimus*
  - *velitaris*
- *Luidia maculata*
- *Archaster laevis*
- *Goniodiscaster acanthodes*
  - *australiae*
  - *bicolor*
- *Styphlaster notabilis*
- *Iconaster longimanus*
- *Anthenoides dubius*
- *Stellaster incei*
  - *princeps*
- *Pseudoreaster obtusangulus*
- *Gymnanthenea globigera*
- *Anthenea australiae*
  - *conjungens*
  - *elegans*
  - *polygnatha*
- *Protoreaster nodulosus*
- *Pentaceraster gracilis*
- *Linckia guildingii*

Hacelia helicosticha
Tamaria megaloplax
tumescens
Asterina anomala
burtonii
lutea
Disasterina spinulifera
Nepanthia tenuis
variabilis
Anseropoda rosacea
Echinaster superbus
varicolor
Metrodira subulata
Retaster insignis

OPHIURANS

Euryale aspera
Ophiacantha clavigera
Amphiura acrisca
bidentata
brachyactis
constricta
leucaspis
micra
microsoma
phrixa
stictacantha
velox
Ophiocentrus verticillatus
Ophionephthys decacantha
octacantha
tenuis
Amphipholis squamata
Amphiodia ochroleuca
Amphioplus didymus
lucidus
relictus
Ophiactis acosmeta
fuscolineata
luteomaculata
modesta
savignyi
Ophiodaphne materna
Ophiothrix exigua
stelligera
Lissophiothrix delicata
Macrophiothrix belli
callizona
calyptaspis
longipeda
scotia
spinifera
Ophiotrichoides martensi australis
pulchra
smaragdina
Placophiothrix lineocoerulea
melanosticta
plana
Ophiomaza cacaotica
Ophiocnemis marmorata
Ophiothela hudra
Ophionereis semoni
stigma
Ophiocoma parva
Ophiomastix notabilis
Ophiurodon cinctum var. *pulchellum*
Ophiochasma stellatum
Ophiarachnella gorgonia
infernalis
rugosa
Cryptopelta callista
Ophiodyscrita acosmeta
Ophiura kinbergi
Dictenophiura stellata
Ophiolepis unicolor
Ophioplocus imbricatus

ECHINI

Prionocidaris bispinosa
Phyllacanthus longispinus
Salmacis sphaeroides
virgulata var. *alexandri*
virgulata var. *alexandri* forma *scalaris*
virgulata var. *alexandri* forma *viridis*
Peronella lesueuri
orbicularis
tuberculata
Fibularia volva
Echinocyamus planissimus
Echinodiscus auritus
Echinolampas ovata
Hypselaster dolosus

- *Temnotrema elegans*
- *Nudechinus darnleyensis*
  - *gravieri*
  - *scotiopremnus*
- *Clypeaster telurus*
- *Arachnoides tenuis*
- *Moira stygia*
- *Rhynobrissus hemiasteroides*
  - *macropetalus*
- *Gonimaretia interrupta*
- *Breynia australasiae*
- *Lovenia elongata*

HOLOTHURIANS

- *Cucumaria semperi*
- *Pentacta australis*
  - *coerulea*
    - var. *rubra*
  - *crassa*
  - *tuberculosa*
- *Leptopentacta grisea*
- *Pseudocolochirus axiologus*
- *Pentathyone mirabilis*
- *Thyone alba*
  - *axiologa*
  - *buccalis*
    - var. *pallida*
  - *grisea*
  - *micra*
  - *minuta*
- *Thyone papuensis*
  - *perissa*
- *Orbithyone megapodia*
- *Staurothyone distincta*
- *Actinocucumis difficilis*
  - *longipedes*
  - *typicus*
- *Pseudocucumis africanus*
  - *intercedens*
- *Phyllophorus parvipedes*
  - *proteus*
- *Urodemas hamatum*
- *Urodemas schmeltzii*
- *Psolus spinuliferus*
- *Stichopus ellipes*
  - *variegatus*
    - var. *pallidus*
- *Holothuria impatiens*
  - *marmorata*
  - *michaelseni*
  - *modesta*
  - *monocaria*
  - *ocellata*
  - *pardalis*
- *Actinopyga lecanora*
- *Paracaudina chilensis* var. *ransonnetii*
- *Aphelodactyla delicata*
  - *leucoprocta*
- *Chondrocloea recta*
- *Leptosynapta dolabrifera*
  - *dyscrita*
- *Protankyra bisperforata*
  - *verrilli*

VII. THE PERTH REGION

The following list includes the echinoderms taken in the area between Geraldton and Bunkers Bay, W. A. In addition, a few species from Carnavon, Shark Bay and the Abrolhos, loaned by the Western Australian Museum, are also included. The total number of species is 96 (with 6 varieties and 1 color form in addition) and no doubt includes most of the echinoderms of the western coast of the continent.

CRINOIDS

- *Comatulella brachiolata*
- *Comanthus trichoptera*
- *Neometra gorgonia*
- *Aporometra occidentalis*
- *Compsometra incommoda*

ASTEROIDS

- *Astropecten hartmeyeri*
  - *preissii*
  - *triseriatus*
  - *vappa*
- *Luidia australiae*
  - forma *brunnea*
- *Archaster laevis*
- *Tosia australis*
- *Pentagonaster dübeni*
- *Goniodiscaster foraminatus*
- *Stellaster inspinosus*
- *Anthaster valvulatus*
- *Gymnanthenea laevis*
- *Anthenea obesa*
- *Austrofromia polypora*
- *Bunaster variegatus*
- *Petricia obesa*
- *Manasterina longispina*
- *Paranepanthia grandis*
  - *rosea*
- *Patiriella gunnii*
  - *brevispina*
- *Parasterina crassa*
  - *occidentalis*
- *Echinaster arcystatus*
- *Metrodira subulata*
- *Retaster insignis*
- *Coscinasterias calamaria*
- *Allostichaster polyplax*

OPHIURANS

- *Astroconus occidentalis*
- *Amphiura constricta*
  - *leucaspis*
  - *microsoma*
  - *nannodes*
  - *ptena*
- *Amphipholis squamata*
- *Amphioplus relictus*
- *Ophiactis acosmeta*
  - *laevis*
  - *resiliens*
  - *savignyi*
- *Ophiothrix caespitosa*
  - *stelligera*
- *Macrophiothrix michaelseni*
  - *sticta*
- *Placophiothrix spongicola*
- *Ophionereis schayeri*
  - *semoni* var. *fusca*
    - var. *nigra*
- *Ophiocoma canaliculata*
  - *occidentalis*
  - *parva*
  - *pulchra*
- *Pectinura assimilis* ? Locality dubious
  - *nigra*
- *Ophiarachnella ramsayi*
  - var. *pulchra*

ECHINI

- *Goniocidaris tubaria*
- *Prionocidaris bispinosa* var. *laevis*
- *Phyllacanthus irregularis*
- *Centrostephanus tenuispinus*
- *Temnopleurus michaelseni*
  - var. *viridis*
- *Temnotrema elegans*
- *Amblypneustes leucoglobus*
  - *pallidus*
- *Holopneustes inflatus*
- *Holopneustes porosissimus*
- *Pseudechinus hesperus*
- *Nudechinus gravieri*
- *Nudechinus scotiopremnus*
- *Heliocidaris erythrogramma*
  - var. *armigera*
  - var. *parvispina*
- *Echinometra mathaei*
- *Clypeaster telurus*
- *Hesperaster arachnoides*
  - *crassus*
- *Peronella lesueuri*
  - *orbicularis*
- *Apatopygus occidentalis*
- *Protenaster australis*
- *Echinocardium cordatum*

HOLOTHURIANS
Cucumaria mutans
Pentacta australis
  coerulea
Phyllophorus cebuensis
  thyonoides
Lipotrapeza vestiens
Psolus granuliferus
Holothuria albiventer
  hartmeyeri
  macroperona
  michaelseni
Paracaudina tetrapora
Leptosynapta dolabrifera
Taeniogyrus cidaridis
Trochodota roebucki

VIII. ALBANY, W. A.

Owing to the large number of forms in the following list of 18 species which are either far south of their expected range, or have not yet been found in the Perth region, it seems best to call attention to the peculiar nature of the marine fauna at Albany by not including them in either the Western Australian or South Australian lists.

CRINOIDS
Comantheria briareus ? Locality dubious.
Comanthus trichoptera
Compsometra incommoda

ASTEROIDS
Astropecten vappa
Nectria multispina
  ocellata
Asterodiscus truncatus
Pseudophidiaster rhysus
Parasterina troughtoni
Plectaster decanus
Allostichaster polyplax

OPHIURANS
Euryale euopla

ECHINI
Temnotrema notium
Amblypneustes pallidus
Heliocidaris erythrogramma
Fibularia volva

HOLOTHURIANS
Pentacta coerulea
Pseudocucumis thomsoni

IX. COASTS OF SOUTH AUSTRALIA AND VICTORIA

The following list consists chiefly of the species collected by Mr. Hale and myself during a single low tide at Port Willunga, S. A., November 2, 1929. There are also included however a number of species collected by Mr. W. J. Kimber, who very generously sent them to the M. C. Z., and a few species loaned by the museums in Adelaide, Melbourne and Sydney.

CRINOIDS

Comanthus trichoptera
Compsometra loveni

ASTEROIDS

Astropecten schayeri
Patiriella brevispina
gunnii
Coscinasterias calamaria
Allostichaster polyplax
Smilasterias irregularis

OPHIURANS

Ophiomyxa australis
Asteroporpa australiensis
Amphiura constricta
Amphipholis squamata
Ophiactis resiliens
tricolor
Ophiocoma canaliculata

ECHINI

Goniocidaris tubaria
Phyllacanthus irregularis
Amblypneustes ovum var. *pachistus*
pallidus
Holopneustes inflatus
Heliocidaris erythrogramma
var. *armigera*
Archaeopneustes niasicus
Moira stygia
Eupatagus dyscritus
Echinocardium cordatum

HOLOTHURIANS

Cucumaria mutans
Pentacta australis
Thyone vercoi
Lipotrapeza ventripes
Holothuria conica ? Locality dubious.
hartmeyeri
Paracaudina tetrapora
Leptosynapta dolabrifera

X. TASMANIA

The species contained in the following list were, with one or two exceptions, either collected by our dredging party in the estuary of the Derwent, November 15, 1929, or were generously given to me that same day by Professor T. T. Flynn of the University. Of course, only a small proportion of the Tasmanian echinoderm fauna is represented.

ASTEROIDS

Tosia aurata
australis
Anthenea acuta
Asterina scobinata
Patiriella calcar
exigua
Coscinasterias calamaria
Allostichaster polyplax

OPHIURANS

Astroconus australis
Ophiacantha heterotyla
Amphiura constricta
Amphipholis squamata

ECHINI

Microcyphus annulatus
Amblypneustes ovum var. *pachistus*
Pachycentrotus australiae
Heliocidaris erythrogramma
Echinocyamus provectus

HOLOTHURIANS

Pentacta australis
Pseudocucumis thomsoni
Lipotrapeza vestiens
Stichopus mollis
Leptosynapta dolabrifera
Chiridota gigas
Trochodota allani

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